

# An Outcome Evaluation of the Centre of Science and Technology

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## **Executive Summary**

This dissertation presents an outcome evaluation of the Centre of Science and Technology (COSAT) programme. COSAT is a secondary school, which differentiates itself from a traditional South African secondary school by focusing its curriculum on science, technology, mathematics, and science (STEM), learning. The long-term objective is the improved retention of low-income black students in STEM disciplines. COSAT's primary activity is providing quality education for learners and encouraging parental involvement.

To evaluate the performance of the COSAT programme this dissertation focused on investigating or addressing two primary evaluation questions. The first evaluation question centres around understanding the academic performance of COSAT learners in comparison to a selection of learners who did not form part of the programme. The second evaluation question centers on understanding the post-school employment and education activities of the COSAT alumni. This contributed to the evaluation of COSAT's long-term objective for improved retention of low-income, black youth in STEM disciplines.

The data used to answer the evaluation questions was provided by two sources. For the evaluation of the academic performance of COSAT learners' secondary data provided by COSAT and the Western Cape Department of Education was used. A comparison was done between COSAT and 4 comparison schools who matched COSAT either on region, quintile or STEM curriculum. For evaluation of the COSAT alumni primary data was collected using an online survey. The survey questions focused on the tertiary education and employment activities of the alumni.

The analysis of COSAT against the comparison schools revealed that COSAT's learners are achieving similar results in the National Senior Certificate exams to learners from better resourced schools. This is a significant finding in the context of South Africa's characteristically unequal education system. While under-resourced schools are often defined by poor academic achievement, COSAT has produced excellent academic achievement despite its limited resource allocation. Additionally, COSAT's STEM focused curriculum is producing learners with better academic

achievement than learners from comparison schools who are similarly resourced but follow the traditional CAPS non-STEM focused curriculum. This is a noteworthy finding for The South African Department of Education and its *National Strategy for Mathematics, Science and Technology Education* (DOE, 2011).

Results revealed that the performance of COSAT learners, specifically the performance of Grade 12 learners in the final NSC examinations in mathematics, physical science and life science has declined over the period 2010 to 2015. Additionally, while the count of learners who received bachelors passes increased, the percentage of all learners who received bachelor's passes decreased. This suggests that the opportunity for tertiary acceptance for a Grade 12 graduate from COSAT has declined between the period 2010 and 2015. It has been suggested that the decline in learner performance over the period 2010 to 2015 has been triggered by demand for growth in learner numbers.

Results from the alumni survey revealed that of those that responded to the questionnaire a large percentage of COSAT learners had enrolled in an institute of higher learning since leaving COSAT and additionally that more than half of those learners are pursuing or have obtained a STEM qualification. COSAT's long term outcome is the improved retention of low-income, black students in STEM disciplines. While it is difficult to determine whether COSAT has contributed to improved access, it is significant to note that more than half of the alumni are pursuing STEM degrees or careers.

In conclusion, COSAT has achieved a high pass rate between 2010 and 2015, however learners' performance in the National Senior Certificate examination in STEM subjects has declined. Additionally, the results of the comparison analyses and alumni survey show significant achievement of the COSAT programme. The COSAT STEM-focused curriculum is producing learners with significantly better academic achievement than non-STEM focused schools that were compared in this study; additionally, more than half of the COSAT alumni are pursuing degrees in STEM disciplines. In ending the evaluation some recommendations are presented, that if implemented, could improve the COSAT programme and future evaluations.

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# Chapter 1

## Introduction

Many governments across the world, from the United States to South Africa, have recently adapted their education policy to focus on science, technology, engineering and mathematics (STEM) learning (Ernst & Glennie, 2015; Baran et al., 2016; Freeman et al., 2014). The fundamental notion of STEM learning policies is to increase or improve performance in STEM related subjects in secondary schooling in order to increase nation-wide performance in STEM disciplines (Wang, 2013). The rationale behind this initiative is premised on the idea that with improved STEM learning the countries' research output, job performance, and innovation will excel in STEM industries (Ernst & Glennie, 2015). Progress in STEM learning is necessary for a world where problems of science, technology and engineering are rising (Wang, 2013).

The South African Department of Education, in its *National Strategy for Mathematics, Science and Technology Education*, states that achievement in mathematics, technology and science education is the key to effective schooling and ample preparation for tertiary education. Yet, a legacy of inequality persists in the participation of South African youth in STEM learning areas (DOE, 2011). South Africa has a poor output of skilled Grade 12 graduates in mathematics and science. This problem is attributed to a lack of qualified mathematics, science and technology educators, as well as adequate facilities and resources (DOE, 2011).

South African students' performance in STEM learning areas is poor (Reddy et al., 2012; Spaul, 2013). A large majority of South African learners are not able to read or write at a grade-appropriate level, with many learners being functionally illiterate and innumerate (Spaul, 2013). South Africa's education system is in crisis and is characterised by unequal access to quality education, poor academic performance and low participation in science and mathematics (Reddy et al., 2012; Spaul, 2013).

Performance in mathematics and science is one of the key indicators of all schooling systems. The Trends in International Mathematics and Science Study (TIMSS), a cross-national assessment of mathematics and science knowledge, highlights that South African mathematics and science scores are low. In the 2011 TIMSS, the

national Grade 8 level, in mathematics and science, fell below the low-performance benchmark and placed South Africa in the lowest 6 places out of 42 countries (Reddy et al., 2012). In the Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ), South African learners were placed 9<sup>th</sup> out of 14 countries in mathematics, with many lower-income African countries such as Botswana, Swaziland and Kenya being placed ahead of South Africa (Spaull, 2013).

Despite the bleak picture described above, South African mathematics and science scores have increased between TIMSS 2002 and TIMSS 2011. It is estimated that between TIMSS 2002 and TIMSS 2011, the mathematics and science score for public schools increased by one and a half grade levels. Although there is evidence of improvement, South Africa is not globally or in some cases regionally competitive and this impacts on the students' ability to progress towards science, technology, engineering and mathematic programmes (STEM) (Reddy et al., 2012). In TIMSS 2011, the five top performing countries had an average scale score of 597.8; while in South Africa, only 3% of South African learners achieved above a scale score of 550. These top performing learners are characteristically found in well-resourced, previously categorized 'former house of assembly' or white schools (Reddy et al., 2012). Consequently, the majority of South African learners are not globally competitive and have unequal access to globally competitive STEM programmes.

It is evident that South African youth face multiple and continuous barriers in their pursuit of educational success. To address poor STEM performance of secondary school learners, the *National Strategy for Mathematics, Science and Technology Education* suggests various interventions, one of which is dedicated mathematics and science schools to increase participation and performance in mathematics and physical science (DOE, 2011). Dedicated STEM schools have been implemented around South Africa however very little is known about the success of these schools, particularly whether learners in dedicated STEM schools perform better in STEM subjects than learners enrolled in other schools or whether the learners from STEM schools have a higher placement rate in STEM degrees. This dissertation will provide an outcome evaluation of a STEM focused secondary school located in the Western Cape; an introduction to the programme will be provided to give context of the evaluation.

## **Programme Description**

The Centre of Science and Technology (COSAT) is a secondary school based in Khayelitsha, Cape Town. The programme description provided herein was developed using the Centre of Science and Technology website (n.d), personal communication with P. Cooper (February 22, 2016), personal communication with P. Silbert (February 29, 2016), and a Western Cape Government (2015) press release. These personal communication sources were used due to a lack of published documents about the programme.

COSAT differentiates itself from a traditional South African secondary school by focusing its curriculum on Science, Technology, Mathematics, and Science (STEM) learning. The long-term objective is the improved retention of low-income black students in STEM disciplines. COSAT's primary activity is providing quality education, while providing psychosocial support to learners, providing development and psychosocial support for teachers, and encouraging parental involvement (P. Cooper, February 22, 2016).

COSAT, implemented by False Bay Further Educational Training (FET) College, opened its school doors in 1999 due to the need for secondary-school graduates from low-income schools who are skilled in STEM disciplines. False Bay College responded by providing a secondary education programme for Grade 10, 11 and 12 learners with a maths and science learning focus. The college invited learners with a high-aptitude mind, who had a strong numerical ability, from surrounding secondary schools in Khayelitsha to complete their secondary schooling with COSAT. There was a belief that COSAT provided an environment together with resources to encourage learner achievement (Western Cape Government, 2015). COSAT's first Grade 12 class graduated in 2001 with a 100% pass rate and many subject distinctions. This was a significant achievement considering the socioeconomic context of the programme and in relation to the setting within the South African education system, as presented in the introduction. COSAT aimed to be a school of excellence with high academic performance and achieved this within their first cohort of graduates (History of the Centre of Science and Technology, n.d).

Due to the initial success of the COSAT academic programme, the Western Cape

Education Department (WCED) registered COSAT as a stand-alone secondary school on 1 January 2011 (Western Cape Government, 2015). This change caused a series of amendments to the programme: firstly, the target population was expanded to include all secondary grades, which includes grade 8 through to grade 12. Secondly, the registration allowed for an increase in the number of learners who could be accommodated in the programme. The student body size increased from 200 learners to 550 learners. Thirdly, the school was classified as a STEM focus school (About the Centre of Science and Technology, n.d). This impacted on the academic curriculum offered by the school (P. Cooper, personal communication, February 22, 2016); this will be explained in more detail below in the 'programme activities' description. Fourthly, a new building in a location (700m from False Bay College) was provided for by the Western Cape Department of Education. This allowed for more physical space and more resources for the learners, such as expanded curricular programmes, more dedicated science laboratories and a student wellness centre (Western Cape Government, 2015).

COSAT since its implementation has achieved immense success in its throughput of highly successful Grade 12 graduates. The school was placed in ninth position in the top ten schools in the Western Cape in 2011. The school was the first township school to place in the top 10 schools in the province. This was based on the 100% pass rate, 79% of its learners receiving bachelor passes, and 98.6% passing mathematics in 2011 (Western Cape Government, 2015). Additionally, COSAT has achieved a 100% pass rate almost every year since its implementation, except for in 2009, 2014 and 2015(P. Cooper, personal communication, February 22, 2016).

COSAT has no formal programme description or written change theory model; this is not unusual as most schools do not have a written change theory model as it is not considered a programme in the traditional sense. This may be due to the mandatory nature of WCED policy and legislation; a programme description or model was not previously needed. However, to develop the questions and focus for this outcome evaluation, it was necessary to extrapolate the inherent outcomes of the COSAT programme and identify the programme logic model. The model was developed using information from the Centre of Science and Technology website (n.d) and personal

communication with P. Cooper (February 22, 2016). The COSAT programme description is presented below.

### **Student Selection**

COSAT's only target is secondary school aged students from grade 8 to grade 12. A campaign, run in Khaylitsha primary schools, encourages principals to refer Grade 7 learners with aptitude in mathematics and science to COSAT. In 2015, this process was altered with the introduction of an admission test. The identified learner is required to complete a Mathematics and Natural Science admission test. The admission test is written at COSAT under controlled conditions. The minimum requirement for admission is to pass with at least 60%. Selections are determined by weighting the admissions test with the learner's previous academic reports. A greater weighting is assigned to the COSAT admissions exam, being a challenging standardized assessment (P. Cooper, personal communication, February 22, 2016).

During selection COSAT is intentional about keeping male-female balance and therefore gender is considered in the selection process. Furthermore, the demand for an annual increase in student numbers means COSAT is required to accept a specific number of learners every year; this is regardless of the learner's performance in the admissions exam. It has been noted that the number of learners required is increasing every year and COSAT is not able to recruit enough learners by selecting only learners who meet the requirements of the admission test (P. Cooper, personal communication, February 22, 2016).

### **Programme Activities**

COSAT currently provides four programme activities in support of STEM learning: (i) quality educational support, (ii) parental involvement, (iii) psychosocial support, and (iv) teacher development. Quality educational support and parental involvement are the key activities of the programme. Psychosocial support activities were only formally implemented in 2016, whilst teacher development activities have been weakly implemented and limited to motivational staff meetings (P. Silbert, personal communication, February 29, 2016). The two latter activities were not considered to be key aspects of the programme preceding 2016 and therefore these activities are

not included in this outcome evaluation which looks at the period between 2010-2015 (P. Cooper, personal communication, February 22, 2016). All current activities are described below. However, focus has been placed on the two relevant activities: Quality education and parental involvement. A brief description of psychosocial support and teacher development activities will be presented to provide the current framework of the programme as of 2016.

### *Quality Educational Support*

COSAT's education activities follow the current national curriculum, the Curriculum Assessment Policy (CAPS) syllabus, which was implemented nationally in 2012. The syllabus provides a detailed and informative document, which informs teachers what to teach and what to assess on a grade and subject level. The aim of the syllabus is to ensure consistency in teaching and provide administrative support for educators (Variend, 2011). Due to the 'STEM' status of COSAT, the subjects made available to the learners are more limited than the standard public school and focus on STEM subjects. The subjects made available to COSAT learners within the respective grades are presented in Table 1. COSAT also supports STEM subject learning through additional educational support which is detailed below (P. Cooper, personal communication, February 22, 2016).

Table 1

#### *Subjects made available by COSAT to Grade 8-12*

| Grades              | Subjects   |
|---------------------|--|
| Grade 8 and 9       | isiXhosa Home Language, English First Additional Language, Mathematics, Natural Sciences, Social Sciences, Technology, Economic and Management Sciences, Life Orientation and Arts and Culture |
| Grade 10, 11 and 12 | isiXhosa Home Language, English first additional language, Mathematics, Physical Science, Life Science and Information Technology and Life Orientation   |

COSAT's first objective is to provide tailored academic support by enriching learners who are high performing and supporting learners who are at risk (About the Centre of

Science and Technology, n.d). Learners who struggle academically have access to extra support and learners who are excelling in mathematics and science have access to enrichment activities (P. Cooper, personal communication, February 22, 2016). All additional support and enrichment activities are listed below.

For 'at risk' learners who require additional support, COSAT provides the following:

- An extended school day, which includes a study hour at the end of the day. Teachers have an environment and allocated time where they can provide extra support.
- COSAT offers Saturday classes provided by external teachers, where extra mathematics and science classes are offered to struggling learners.

For advanced learners, the following enrichment activities are provided:

- University of Cape Town (UCT) and UCT Schools Improvement Initiative partnership: part of the *100 UP* campaign, 5 learners are selected from multiple schools and are provided with supplementary classes on a Saturday.
- Robotics curriculum: *SERI* provides a structured robotics course for Grade 8 and 9 learners once a week.
- AP Mathematics: Learners who score above 80% for mathematics are invited to form part of the AP Maths programme. In reality, learners with 65% or more are accepted. The programme is provided to Grade 10's through to Grade 12's. With the national curriculum only including AP Mathematics at a Grade 12 level, the aim of the COSAT AP Mathematics intervention is to provide early exposure to the learners. This intervention has a high attrition rate. Thirty Grade 10 learners began the AP programme in 2012, while only 10 completed the exam in Grade 12 in 2014.
- Extra mural interventions: COSAT provides various extra mural interventions, such as debating. The Township Debating League, from UCT, assists with coaches.

In addition to the interventions listed above COSAT performs regular assessment and feedback sessions. COSAT provides seven student progress reports, as opposed to the prescribed four progress reports, during the academic year. The purpose of this is to provide regular feedback to the learners and their families, as well as to provide an opportunity to extend encouragement to improved learners. This process is done

through 'choc awards', whereby a chocolate is awarded to the top four academic learners per grade, as well as to individuals who have shown major improvement. The candidates are finalised by the COSAT principal and the awards are presented during the school assembly (P. Cooper, personal communication, February 22, 2016). This highlights that the intervention is not dependent on the value of the reward but rather the process of acknowledgement.

### *Parental Involvement*

COSAT's second objective is to support parental involvement in order to reinforce the school programme and activities (About the Centre of Science and Technology, n.d). COSAT's parental involvement programme includes (i) effective communication between parent and educators and (ii) involvement of parents in the student governing body.

To encourage effective communication between parent and educators, COSAT hosts quarterly parent meetings. These meetings provide an environment for teacher and parent interaction, celebration, or troubleshooting the student's performance for that quarter. Secondly, COSAT encourages trust and continual communication between school management, teaching staff and parents. For example: if there are behavioural issues or if the student is absent for more than 2 days, the teacher or principal will communicate with the parent via a telephone call or meeting (P. Cooper, personal communication, February 22, 2016).

Parental involvement is encouraged through an active student governing body (SGB). Every 3 years an election is held to elect the new SGB. The COSAT parent body selects the parent component of the SGB, which constitutes 7 of the 13 members. This allows for the parents to be in the majority on the SGB. The remaining positions are filled with two students, one public staff member, two teachers and the principal. The student positions are selected by the Representative Council of Learners (P. Cooper, personal communication, April 25, 2016).

### *Psychosocial support*

COSAT's third objective is to provide programmes that allow for the holistic development of the learner (About the Centre of Science and Technology, n.d).

Khaylitsha is a low-income and under-educated community. Only 40% of the working age population are employed, and 73.7% of the households in Khaylitsha have a monthly income of below R3200 (City of Cape Town, 2013). Children growing up in poverty confront a wider range of physical and psychosocial stressors than children growing up in a middle-income environment (Evans & English, 2002). COSAT has responded by providing psychosocial support for learners and staff through the COSAT Wellness Centre, and by partnering with The Science Education Resource Initiative (SERI), this is expanded on below.

The UCT Schools Improvement Initiative (SII) runs the COSAT Wellness Centre. The centre was conceptualized and researched in 2014 and 2015, and was implemented in 2016. In the research phase it was found that the students and staff had significant social and emotional needs which were not being met (P. Cooper, personal communication, February 22, 2016). The centre aims to encourage a holistic, balanced and healthy lifestyle by providing both social work services and physical health services (P. Silbert, personal communication, February 29, 2016).

SERI, a non-profit organisation which acts as a supportive arm of COSAT, provides financial support, educational support and social support to learners. The financial and educational support provided is evident in the provision of a library and librarian, provision of the robotics curriculum, and provision of other extra mural programmes. However, many of the social needs of the students cannot be addressed directly by COSAT. SERI provides social support to the learners, which can include food parcels and financial support (P. Cooper, personal communication, February 22, 2016).

### *Teacher Development*

COSAT aims to provide support and opportunities for development of staff (About the Centre of Science and Technology, n.d). Currently this objective is limited to the COSAT wellness committee and extra curricula support for staff.

The COSAT wellness committee is made up of selected teaching staff as well as participants from the UCT SII Wellness Centre, mainly the resident social worker. The purpose of the COSAT Wellness committee is to research, plan and provide for the wellness and wellbeing of the teaching staff. The aim is to highlight the needs of the

staff and problem-solve to meet or provide for the highlighted needs. However, this has not been formally implemented.

COSAT aims to keep teaching staff proficient by providing extra support through monthly staff meetings. Furthermore, if teachers require extra support then external support is invited; the process is facilitated by the COSAT principal, deputy principal and head of departments (P. Cooper, personal communication, February 22, 2016).

In summary, quality education and parental involvement are COSAT's key activities. Quality education is implemented using a quality STEM focused curriculum, support for at-risk learners and enrichment for advanced learners, as well as achievement award ceremonies. Parental involvement is facilitated through regular learner progress reports, open channels of communication and involvement in the SGB. Now that the activities have been presented, the programme theory will be discussed and the logic model of the programme will be presented.

### **Change Theory**

A programme change theory is “the conception of what must be done to bring about the intended social benefits” (Rossi et al., 2004, p. 134). It is the foundation on which all programme activities and structures lie. The accuracy of the change theory impacts on whether the programme attains the desired results. An essential aspect of evaluation is to evaluate the plausibility of the change theory. However, before that can be done, the change theory needs to be established and expressed (Rossi et al., 2004).

As is common for a secondary school, COSAT's programme theory was not yet available in a document format, and it was the role of the evaluator to generate a model. The evaluator elicited the model through three 1 hour interviews with the COSAT principal (February 22, 2016; February 29, 2016; April 25, 2016), reviewing the Centre of Science and Technology website (n.d), and reviewing press releases from the Western Cape Government (2015). An initial model was developed and reviewed by the COSAT principal, who then approved the accuracy of the model. The main assumption underlying COSAT's theory is that any learner who shows an

aptitude towards maths or science, who is then provided with quality education in STEM subjects and familial support, will succeed and actively pursue careers in STEM disciplines.

The logic model for COSAT is provided on the next page. The model highlights the inputs, activities, outputs, initial outcomes, intermediate outcomes and longer-term outcomes of the COSAT programme. The activities and initial outcomes which are in blue and italicized are the newly implemented activities and will not be addressed in this evaluation.

The COSAT logic model (Figure 1 on page 20) shows that learners from Khayelitsha, who engaged in a high quality high school education programme, which is made up of quality STEM education and parental involvement, should have grade appropriate knowledge and familial support systems. This combination should result in increased academic performance and therefore improved retention of Grade 12 learners from low-income socioeconomic contexts in post-secondary STEM-focused education and employment.

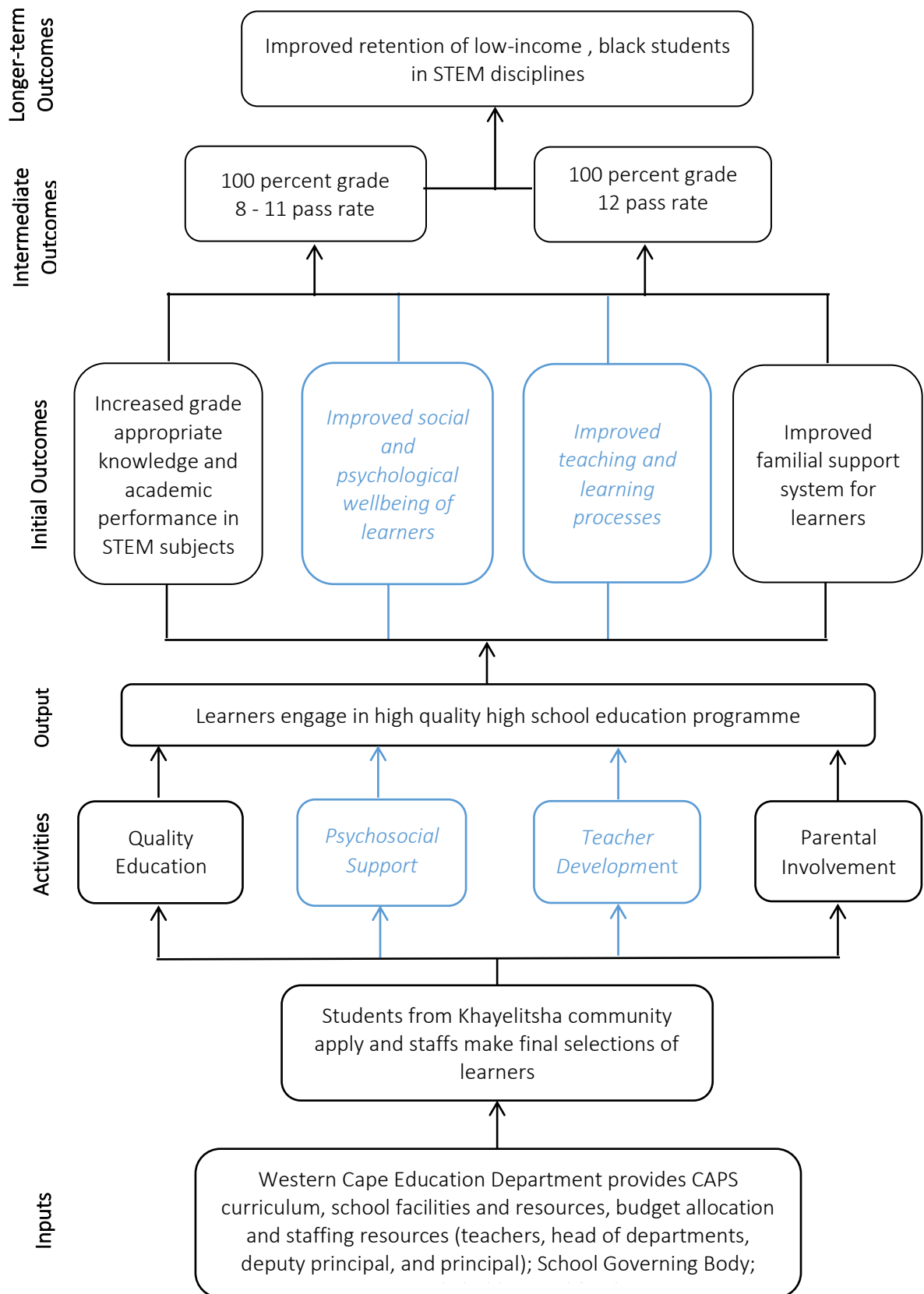


Figure 1: Logic model for Centre of Science and Technology (COSAT)

Now that the COSAT logic model has been presented, the plausibility of the logic model will be discussed. This is a process of assessing the programme theory or logic model through comparison with contemporary research (Rossi et al., 2004).

### **Plausibility of Programme Theory**

In evaluating the plausibility of the programme theory, the fundamental assumptions and activities of the programme are assessed in terms of their likelihood of causing the intended outcomes. There are several causal assumptions underlying the COSAT programme:

- Quality STEM focused education will lead to improved grade appropriate STEM knowledge and STEM academic performance.
- Parental involvement supports learning and academic achievement.
- Quality STEM education and parental involvement are key influencing factors of participation in a STEM-related degree or field.

To assess the plausibility of these assumptions, a literature review of STEM academic programmes as well as theories of influencing factors of STEM participation was conducted. The literature review was carried out between the 3 March and 15 December 2016 using relevant databases such as EBSCOHost and Google Scholar, made available by the University of Cape Town library website. Search terms originated from the programme theory, and therefore varied depending on the specific causal assumption. Search terms used for STEM education were (STEM education AND secondary school AND South Africa) and additional terms used were (evaluation; impact; knowledge; academic performance). For parental involvement search terms used were (parental involvement AND secondary school AND academic performance). For STEM discipline search terms used were (STEM discipline AND influencing factors). Additional research which related to relevant articles was included. The search was conducted within a limited time frame, mainly the years 2000 to 2016 to ensure research was both broad and current.

## **Will quality STEM focused education lead to improved grade appropriate STEM knowledge and STEM academic performance?**

A common thread in research on quality education refers to the quality and availability of teachers (Healy et al., 2011); teacher quality has a positive relationship with student performance. The strongest correlates for student achievement in mathematics are found to be teacher preparation and teacher certification (Darling-Hammond, 2000). A complex interaction of teacher's academic skills and knowledge, the level of mastery of content, the level of experience and the pedagogical skill all interact and impact on student achievement. This is especially true for mathematics and science teachers; teachers who have a major in the subject they teach elicit higher student performance (Peske & Haycock, 2006; Hudson et al., 2015).

To show improved STEM knowledge and STEM academic performance it is important to show what motivates students to learn and achieve in mathematics. When learners are self-motivated or have self-regulatory learning behaviours they have improved or advanced mathematic achievement (Leon et al., 2015). While prior achievement and intelligence predict the greatest variance in mathematic achievement, motivation is a significant mediator (Kriegbaum et al., 2015; Kriegbaum & Spinath, 2016). One predictor of self-regulated learning is a supportive and responsive teacher and learning environment (Leon et al., 2015).

STEM education is correlated to improved STEM academic performance. A study conducted in the United States assessed learners who were admitted to ten STEM-focused schools. The learners were admitted through a lottery process or all learners were accepted; this controls the effect of prior academic achievement. Additionally, the school population had a higher number of minority learners compared to other schools. The research showed that students successfully graduated with high achievement scores, providing evidence for the impact of STEM-focused schools (Scott, 2012).

These studies show that quality education in the form of qualified and skilled teachers have a positive relationship with STEM subjects. This relationship is due to both the quality of the teaching in the classroom as well as the teacher's impact on the motivation of the student to engage in self-regulated learning.

## **Will parental involvement support learning and academic achievement?**

Researchers have shown that parental involvement and support can encourage academic achievement (Hill, 2015). This is particularly true for STEM subjects such as mathematics (Aligbe, 2015). The relationship between parental involvement and educational outcome depends on the type of parental involvement provided (Catsambis, 2001; Gonida & Cortina, 2014). Here the researcher will discuss two types of parental involvement: (i) communication between the parent, child, and school about academic progress and performance and (ii) role of parental involvement in school governance (Catsmabis, 2001; Gonida & Cortina, 2014).

### *Communication between the parent, child, and school about academic progress and performance*

Many parents and teachers believe that communication is the most important form of parental involvement (Garcia, 2015). Communication between parent and child is an opportunity for discussion about high expectations of academic performance and consistent encouragement. These two forms of communication or practices are found to positively affect academic experiences of secondary school learners (Catsambis, 2001; Jeynes, 2003).

Familial expectation of the learner, often despite parent's academic success, is found to impact on the resiliency of the learner, specifically learners from stressor-heavy contexts (Dass-Brailsford, 2005). A similar relationship exists with the role of encouragement; parents who encourage their children to prepare for university or college during high school have children who are high performing learners (Catsambis, 2001). The research presented here used participants from all schools and not only STEM-focused schools, this should be considered when reviewing the literature.

### *Role of parental involvement in school governance*

Involvement in parent-school organisations such as the school governing body gives the parent the opportunity to influence school policy and directly impact children's academic activities. It is assumed that involvement at this level also communicates a value and importance of education and success (Stewart, 2008). However, it is

important to note that parental involvement in the form of participation in parent-school organisations is not as effective as the previously mentioned form of involvement. Parent-student academic conversations (which would typically include communication of expectation and encouragement) are more highly correlated to academic achievement than parental involvement in parent-school organisations (Stewart, 2008). The research presented here used participants from all schools and not only STEM-focused schools. This should be considered when reviewing the literature.

Taken together, a pattern of the impact of parental involvement in learner academic performance and participation is evident. Two crucial forms of parental involvement are: (i) communication about academic programme and progress between the parent and school and (ii) parent volunteering and participation at school, although this was found to be the least effective form of involvement (Catsambis, 2001). COSAT programme includes parent-school communication about academic programme and progress through progress reports and termly meetings. Additionally, COSAT provides opportunities for volunteering and participation at school through the School Governing Body (SGB). COSAT does not provide communication about potential home-based learning activities, which has been highlighted as an effective form of parental involvement. COSAT may want to include this, given the benefits. Therefore, with the endeavour of pursuing mathematics and science subjects, parental involvement is an essential part of an effective academic programme.

### **Are quality STEM education and parental involvement crucial influencing factors in a learner's pursuit of a STEM degree?**

Career trajectory is a very difficult outcome or behavior to predict or determine with a small set of variables. It is a complex interaction of several covariates. Yet there are numerous factors which have been found to influence the choice of discipline and specifically the choice of pursuing a STEM discipline. This is a crucial insight in terms of analyzing the plausibility of the COSAT programme theory.

#### *STEM education and the pursuit of a STEM degree*

The research presented here is from an international context as little relevant South African research could be located. Therefore the context of the study should be

considered when reviewing the presented literature. Moore (2006), through a minor qualitative study, attempted to identify which factors influence African-American males in pursuing a degree and career in engineering. Key factors which influence career trajectory of African-American males are (i) a solid interest in science, technology, engineering and mathematics (STEM subjects), (ii) supportive family with high levels of interest and encouragement, (iii) strong abilities in science and mathematics, (iv) significant academic experiences and significant relationships with academic staff, and (v) significant enrichment opportunities and programmes. This review will focus on the influence of meaningful STEM educational experiences as well as the influence of parental involvement on STEM participation.

In the United States of America research assessing the college and career readiness of learners who attend STEM focused schools shows that learners who are more interested in STEM subjects perform better in mathematics and science assessment, are more willing to attend classes and are more likely to earn college degrees (Erdogan & Stuessy, 2015). Additionally learners who have prior interest in STEM-related fields who attend specialized science, technology and mathematics (SMT) focused schools have an improved rate of enrollment in a STEM-related major. In Table 2 it can be seen that for 'initially STEM-interested learners' a specialized SMT school increased enrollment in STEM-related majors, including high performing learners.

Table 2

*Comparison of percentages of tertiary education graduates majoring in STEM related fields from specialized SMT schools (Tai et al., 2011)*

| Interest in STEM                       | Type of schooling and performance   | Graduates majoring in STEM related field (percentage) |
|--|---|---|
| Initially STEM-interested Students     | Comparison high School graduates  | 40.7%   |
|  | Comparison High School graduates with high achievement in Science and Mathematics | 46.6%   |
|  | Specialized SMT High School Graduates   | 64.9%   |
| Initially non-STEM interested students | Comparison high School graduates  | 21.9%   |
|  | Comparison High School graduates with high achievement in Science and Mathematics | 34%   |
|  | Specialized SMT High School Graduates   | 27.5%   |

While it is evident that for STEM interested learners a STEM focused school highly influences the uptake of a STEM major, Wang (2013) showed that Grade 12 mathematic achievement, exposure to mathematics and science curriculum and mathematics self-efficacy beliefs influenced the outcome of a student pursuing a STEM degree. However, it highlighted that this influence was larger for white students than under-represented minority students (Wang, 2013). This potentially highlights other influencing factors or barriers for minority students. It is essential to note that many of these studies were conducted in resource rich environments which influences the positive findings of these studies. The socioeconomic context of the COSAT learners adds an additional challenge to the pursuit of a STEM degree.

### *Parental involvement and pursuit of STEM degree*

Peers, faculty and administrative staff, family and community, known as socializers, provide an important motivation for students (Hrabowski & Maton, 1995; Dick & Rallis, 1991). This cohort of socializers has the opportunity to play a supportive role, which nurtures effort and enthusiasm, or alternatively be a distraction and stress for the student, which belittles the student's effort and enthusiasm. The more supportive interventions the student receives to help buffer against stress and distraction, the greater the chance of students' success (Hrabowski & Maton, 1995).

Moore (2006) highlights the importance of familial roles specifically in the selection of a student's academic major. Family provides guidance, encouragement and support. This is especially evident for students (both men and women) who are choosing careers in STEM disciplines, specifically engineering and science. Many students who do select STEM disciplines have had some form of direct encouragement to do so (Dick & Rallis, 1991).

It is important to note that there are many barriers and influences which impact on the preparedness of high school graduates. STEM degrees usually take longer to complete and therefore financial capital impacts on the ability of learners to remain in STEM programmes (Crisp et al., 2009; Kruse et al., 2015; Wang, 2013). The intent to major in a STEM discipline and initial tertiary academic experiences have a large influence on STEM pursuit.

In conclusion, it is evident that an educator who has majored in a STEM related subject positively influences both the student's achievement and the student's motivation for achievement. It is also evident that communication between the parent, child, and school about academic progress and performance positively affects academic experiences of secondary school learners. Additionally, research has shown that involvement in a STEM programme can positively contribute to a learner's pursuit of a STEM focused degree. Thus, the positive relationship between COSAT's activities and intended outcomes is plausible. However, there exists a complex web of barriers and influences on a student's pursuit of a STEM degree, and it therefore cannot be presumed that the mentioned activities are the only influencing factors. In consultation

with the school head of COSAT and after a plausibility analysis the following evaluation questions were generated to assess the impact of the COSAT programme.

### **Evaluation Questions**

The evaluation of the COSAT programme will use an outcome evaluation design, this is an appropriate level of evaluation based on the maturity of the COSAT programme as well as the plausibility of the programme theory. An outcome of any programme is the state or condition of the target population that the programme intends to have changed. Therefore, this evaluation measures the magnitude of the programme impact on the social condition it addresses, in terms of the intended improvements. Additionally, the assessment measures whether the intended outcomes were achieved and what unintended consequences may have come about (Rossi et al., 2004). The evaluation questions are therefore based on outcomes described in the programme theory of COSAT:

1. To what extent does the COSAT programme increase STEM knowledge and academic performance compared to select learners who do not form part of the COSAT programme?
2. To what extent does the COSAT programme effectively improve the retention of low-income, black youth in STEM disciplines?

The methods of assessing these evaluation questions will be discussed in the next chapter.

## Chapter 2

This outcome evaluation has been designed to investigate the effect of the COSAT programme. The programme outcomes were determined through the elicitation of the programme impact theory (see page 20), discussions with important stakeholders, as well as through reviewing prior research of STEM education. The research design used to answer each evaluation question is presented below.

**Evaluation Question 1: To what extent did the participants of the COSAT programme have increased academic performance compared to a selection of learners who did not form part of the programme?**

### Research design

To measure the academic performance of the participants of COSAT a quasi-experimental non-equivalent group design was utilized. The design included comparisons of three groups: the intervention group, i.e. the beneficiaries of the COSAT programme, and two comparison groups, i.e. those who did not form part of the programme. The two comparison groups were (i) two non-STEM schools in the same quintile (2 or 3) and region (Western Cape), and (ii) two STEM-schools in a higher quintile (4 or 5) within the same region (Western Cape).

A quintile is a category or ranking of poverty and determines allocation of resources per the National Norms and Standards for School Funding. Schools in Quintile 1, 2 and 3 are no-fees schools and rely 100% on state subsidy. Schools in quintile 4 and 5 are fee paying schools and are generally better resourced.

These comparison groups were selected to limit the influence of other plausible explanations of effects found in the study such as socioeconomic factors as well as unequal resource allocation and education quality. It is essential to compare COSAT to schools that are similarly resourced (quintile), that received learners with similar socioeconomic circumstances and prior education (region), and that followed a similar education curriculum (STEM school). This evaluation design used 5 years' worth of national senior certificate results of Grade 12 learners during the periods 2010 to 2015. This timeframe was selected due to substantial changes in the school structure prior

to 2010. One of these changes was the introduction of the Grade 8 and Grade 9 cohort, which meant COSAT now provided a full high school programme. Therefore, the evaluation used data from a timeframe when the COSAT programme structure was stable.

### Participants

The participants in the intervention group, those who formed part of the COSAT programme, were past students who matriculated between 2010 and 2015, as well as current Grade 9, 10, 11 and 12 students who attended COSAT during the period 2014 and 2015.

The participants in the comparison groups, who were selected using stratified sampling, were (i) two non-STEM schools in the same quintile(s) and region, and (ii) two STEM-schools within the same region. COSAT is a quintile 3 school, however for this evaluation schools were selected from quintile 2 and 3. Table 3 depicts which characteristics each comparison group shares with the treatment group.

Table 3  
*Characteristics of comparison groups*

|                   | Region (Western Cape) | Quintile (2 or 3) | STEM |
|-------------------|-----------------------|-------------------|------|
| STEM School A     | ✓                     |                   | ✓    |
| STEM School B     | ✓                     |                   | ✓    |
| Non-STEM School C | ✓                     | ✓                 |      |
| Non-STEM School D | ✓                     | ✓                 |      |

The groups were selected using stratified sampling. Stratified sampling is when the population is divided into separate groups, such as regions or quintiles, which are called strata, and then a simple random sample is drawn from each stratum (Frankel, 2013). Despite using a sampling method to achieve comparable groups there are still noteworthy differences between the schools which must be highlighted. Most importantly, the size of the student body differs notably between COSAT and the non-STEM schools, with COSAT having 552 learners in 2016 and non-STEM school C and non-STEM school D having 1253 and 1270 learners respectively. This difference could significantly bias the study by making the characteristics of the schools

incomparable but note that the classroom to learner ratio is similar across all groups. Possibly the classroom to learner ratio, which is the number of learners per classroom, is more important than overall school size and so the bias of the difference in school size may be limited. Additionally, there is a large difference between COSAT and STEM school A in availability of science laboratories and libraries, with COSAT having almost half the available facilities compared to STEM school A. These differences will be accounted for in the analysis. The features of each of the comparison schools are presented in Table 4.

Table 4  
*Features of COSAT and comparison schools*

| School            | Average school fee per learner | Total learners (2016) | Number of classrooms | Classroom to learner ratio | Number of science laboratories | Number of computer classrooms | Number of libraries |
|-------------------|--------------------------------|-----------------------|----------------------|----------------------------|--------------------------------|-------------------------------|---------------------|
| COSAT             | n/a                            | 552                   | 18                   | 30.67                      | 3                              | 3                             | 1                   |
| STEM School A     | R4500                          | 405                   | 15                   | 27                         | 7                              | 5                             | 1                   |
| STEM School B     | R6200                          | 476                   | 15                   | 31.74                      | 2                              | 1                             | 1                   |
| Non-STEM School C | n/a                            | 1253                  | 39                   | 32.12                      | 2                              | 1                             | 1                   |
| Non-STEM School D | n/a                            | 1270                  | 39                   | 32.56                      | 2                              | 2                             | 1                   |

## Materials

In endeavouring to answer the question of academic performance of COSAT learners, in comparison to selected learners, two sets of secondary data were used. For the academic achievement of the intervention group, learners of the COSAT programme, secondary data was provided by the principal of the programme.

The secondary data provided by COSAT included all available academic records for Grades 8 – 12 for the period 2010 – 2015 excluding 2011. COSAT was unable to source the academic records of the 2011 cohort. The data were made available to the researcher in the form of hardcopy learner progress reports. Each progress report

provided the results for each written subject as well as a status of progress, for example, bachelors pass or an equivalent result. Please see Appendix A for an example of the data post capturing. This data were used for the initial descriptive analysis of COSAT's learners

To assess the comparison schools, secondary data were made available by the Western Cape Department of Education (WCED). The data exhibited exam pass rates and exam averages for the National Senior Certificate exams for the subjects Mathematics, Physical Science and Life Science for the period 2010 to 2015. The data were presented in a format which showed an average mark for each year for each subject for each school. Please see Appendix B for an example of the data provided. The data made available by the WCED differed in format and presentation to the data provided by COSAT therefore, for the contrast of COSAT and the comparison schools this data were used.

### **Procedure**

To obtain the secondary data required for the analysis of the COSAT learner performance, the evaluator obtained hard copies of the WCED Progression and Promotion Schedule from COSAT. Permission was granted by the Principal of COSAT who then provided the data. The schedule, which is produced at the end of each school term, is a record which provides a summary of the progress of all the learners of each grade in the school. The purpose of the document is to approve the promotion or retention of the learners. The final schedule of each year, which is the document utilised in this evaluation, is signed by the principal and a representative of the WCED, and is then considered a legal document (Western Cape Education Department, 2007). Once the schedules were received by the evaluator, the data were then captured and cleaned ready for analysis.

The evaluator cleaned the data by identifying which learners were listed on the progress reports but were not registered COSAT learners. These learners used COSAT as an exam station but were not registered learners at the COSAT school; this was irrelevant data for this study. These learners were identified by their status in the schedule which listed them as being 'incomplete' candidates.

For the second set of data, a request was submitted to the Director of Research within the WCED. Once approval was obtained the data were emailed to the evaluator by the WCED. The data were then imported into SPSS and stripped of identifying information, such as school name and centre numbers. The schools were given pseudonyms such as STEM School A and non-STEM school C.

### **Analysis of data**

The data made available by COSAT was analysed using descriptive statistical methods. These descriptive methods were used to better describe learner performance at COSAT between 2010 and 2015. Additionally, the data were analysed using the statistical method of analysis of variance (ANOVA). ANOVA was used to analyse the variance between the academic years to determine any changes or fluctuations in academic performance.

The data made available by the WCED was analysed using the statistical method of ANOVA. ANOVA was used to analyse the variance in learner performance between COSAT, the STEM schools and the non-STEM schools. All quantitative data were analysed using IBM SPSS Statistics 23.0.

### **Research Ethics**

Ethical clearance was acquired from the University of Cape Town Faculty of Commerce Ethics of Research Committee. The secondary data provided by COSAT was provided with their consent; a permission letter had been completed. The researcher protected the identity of the beneficiaries found in the secondary data by providing each beneficiary with a unique random number. The secondary data provided by WCED was provided with approval of the research by the WCED Directorate of Research. The researcher protected the identity of the included schools by providing each school with a pseudonym, e.g. non-STEM school D. All information provided was kept confidential and was stored in an encrypted folder on a password-protected computer.

## Evaluation Question 2: To what extent does the COSAT programme effectively improve the retention of low-income, black youth in STEM disciplines?

### Research Design

To measure the participation of COSAT alumni in a STEM related discipline, a single group post-test only design utilizing survey research methods was used. The best way to obtain information about the post-secondary school activities of the COSAT alumni was through use of an online survey. The alumni were spread out geographically and the COSAT administration did not have updated contact details for the alumni. Therefore, an electronic survey would facilitate the greatest reach while still providing valuable information.

### Participants

The participants were selected by applying a convenience sampling approach. This approach uses a sample made up of participants close at hand (Punch, 2005). Participant selection was conducted utilising purposeful canvassing of COSAT alumni (using COSAT records), as well as recruiting through COSAT's social media platforms, namely COSAT's Facebook page. Of the 126 completed responses, 26 surveys were removed due to being incomplete, two were removed as the participants were still enrolled at COSAT, one was removed as the respondent did not attend COSAT and one was removed as the respondent had only completed Grade ten at COSAT and was therefore not a COSAT graduate. The remaining participants (n = 96) had a mean age of 23.67 and largely completed their high school career in 2010, refer to Table 5 on page 35.

Table 5  
*Descriptive statistics of survey participants*

|                             | N  | Minimum | Maximum | Mean  | Std. Deviation |
|-----------------------------|----|---------|---------|-------|----------------|
| Age                         | 95 | 18      | 34      | 23.67 | 3.940          |
| Year of Grade 12 graduation | 95 | 2002    | 2015    | 2010  | 3.808          |

## Materials

To assess the participation of COSAT alumni in the STEM discipline, a survey, which was developed by the researcher, was distributed to COSAT alumni. The survey questions (see Appendix C) were designed to assess the tertiary education of the alumni as well as employment activities of the alumni with a focus on involvement in the STEM field. Firstly, the survey aimed to determine how many COSAT alumni had enrolled in an institute of higher learning. For the participants who did not enrol, a question was presented about why they had not enrolled, providing multiple choice options such as not being accepted to a tertiary institution or a lack of funding. For those who had enrolled in an institute, questions focused on what degree programme they were currently enrolled in or had graduated with, and what their highest level of qualification was. Additional questions related to employment and the industry of the employer were also included.

Some informative questions about what influenced the participants to select their chosen field of study were included to compare to some of the literature about motivating factors of youth involved in STEM programmes. The survey allowed participants to select more than one influencer. This is due to research which shows that individuals experience multiple barriers and multiple influencers in the selection of their field of study. Figure 2 highlights how a participant would flow through the survey.

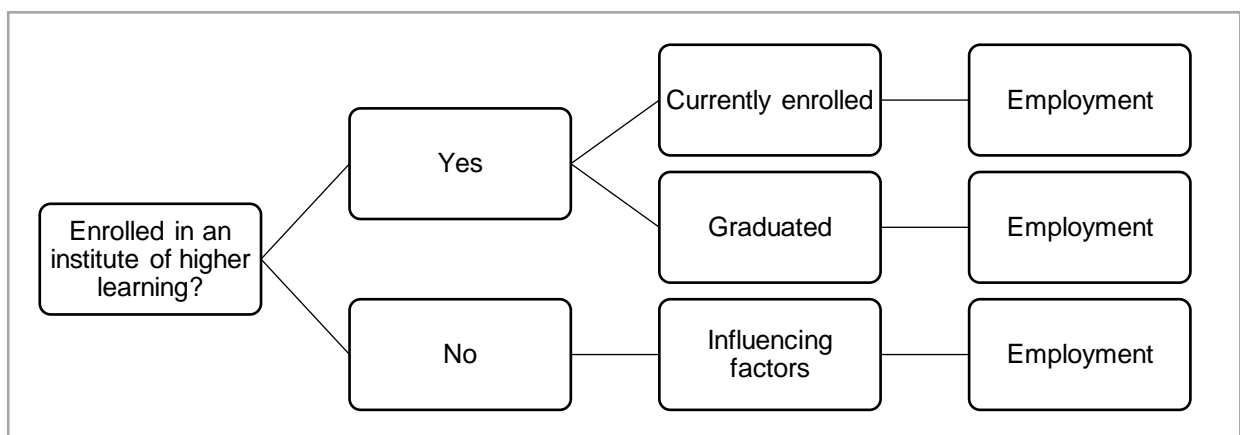


Figure 2. *Flow of survey questions*

## **Procedure**

The survey was developed through a review of relevant literature and was posted online using the Qualtrics platform. Once it was published, the survey link was shared on the COSAT Facebook page together with essential information, such as the incentive, to attract participants. Participants could click on the link and it would direct them towards the Qualtrics platform. Additionally, the researcher used the Facebook Messenger platform to individually message COSAT alumni. This was done by identifying individuals that interacted with posts on the COSAT Facebook page. If they had interacted on the page, the researcher then investigated whether they listed that they had attended COSAT in their *Work and Education* information within their Facebook profile. The researcher then sent them an invitation to partake in the survey. Furthermore, the researcher created a Facebook page titled *COSAT Alumni Survey 2016* to attract additional participants.

## **Analysis of data**

The data made available by the COSAT alumni survey was analysed using descriptive statistical methods. In the classification of degrees as STEM the following method was used: all BSc and medical degrees, diplomas or certificates within the sciences; all engineering degrees, diplomas, or certificates; all technology degrees, diplomas or certificates; and all mathematics degrees, diplomas or certificates were classified as STEM. All other degrees, including BCom degrees and equivalents, were classified as other. All quantitative data were analysed using IBM SPSS Statistics 23.0.

## **Research Ethics**

Ethical clearance was acquired from the University of Cape Town Faculty of Commerce Ethics of Research Committee. During the collection of the primary data the names of the participants were requested to confirm the participant was a COSAT alumni. However, this information was kept confidential and the data were stripped of any identifying information during analyses. All information provided was kept confidential and was stored in an encrypted folder on a password-protected computer.

## Chapter 3

In this chapter, the results of the data analysis will be presented. The analysis used descriptive statistical tests and ANOVA statistical tests to answer the two evaluation questions. The results will be presented in a logical manner, following the order of the evaluation question.

### **To what extent did the participants of the COSAT programme have increased academic performance compared to learners who did not form part of the programme?**

This evaluation question was analysed by firstly looking at the performance of the COSAT learners between 2010 and 2015, specifically the performance of the Grade 12 learners in the National Senior Certificate (NSC) examination. Secondly, the performance of the COSAT Grade 12 learners in the NSC examination was compared to two non-STEM schools and two STEM-schools' performance in the NSC exam. The analysis of the COSAT learners and comparison schools focused on subject performance in Physical Science, Information Technology, and Mathematics. The analyses focused on these four subjects as they are the subjects that characterize a school as a STEM school, and are therefore key to COSAT's success.

Two data sets were used for this analysis. The first was used to analyse the performance of the COSAT learners, and the second was to compare COSAT to the comparison groups. During the cleaning of the first data set, outliers were controlled using winsorizing. Winsorizing is a process of replacing the identified outliers with the highest score which is not an outlier (Field, 2013). The first data set was not normally distributed; this is shown with the *Kolmogorov-Smirnov* and *Shapiro-Wilk* test presented in Table 6. The test produced a statistically significant result, which indicates that the data is statistically different from a normal distribution (Field, 2013). Therefore, all analyses used bootstrapping methods to control for normality (Field, 2013).

Table 6  
*Tests of Normality*

|                                 | Year of data | Kolmogorov-Smirnov <sup>a</sup> |    |       | Shapiro-Wilk |    |      |
|---------------------------------|--------------|---------------------------------|----|-------|--------------|----|------|
|                                 |              | Statistic                       | df | Sig.  | Statistic    | df | Sig. |
| Life Science Mark (%)           | 2015         | .092                            | 95 | .046  | .971         | 95 | .035 |
|                                 | 2014         | .068                            | 73 | .200* | .969         | 73 | .067 |
|                                 | 2013         | .095                            | 65 | .200* | .972         | 65 | .156 |
|                                 | 2012         | .116                            | 57 | .055  | .971         | 57 | .193 |
|                                 | 2010         | .100                            | 46 | .200* | .980         | 46 | .604 |
| Mathematics Mark (%)            | 2015         | .094                            | 95 | .039  | .963         | 95 | .009 |
|                                 | 2014         | .108                            | 73 | .035  | .980         | 73 | .309 |
|                                 | 2013         | .085                            | 65 | .200* | .967         | 65 | .082 |
|                                 | 2012         | .079                            | 57 | .200* | .981         | 57 | .520 |
|                                 | 2010         | .116                            | 46 | .145  | .951         | 46 | .050 |
| Information Technology Mark (%) | 2015         | .100                            | 95 | .021  | .964         | 95 | .010 |
|                                 | 2014         | .071                            | 73 | .200* | .983         | 73 | .417 |
|                                 | 2013         | .078                            | 65 | .200* | .964         | 65 | .057 |
|                                 | 2012         | .118                            | 57 | .048  | .910         | 57 | .000 |
|                                 | 2010         | .082                            | 46 | .200* | .985         | 46 | .795 |
| Physical Science Mark (%)       | 2015         | .138                            | 95 | .000  | .949         | 95 | .001 |
|                                 | 2014         | .077                            | 73 | .200* | .981         | 73 | .359 |
|                                 | 2013         | .081                            | 65 | .200* | .965         | 65 | .061 |
|                                 | 2012         | .107                            | 57 | .163  | .969         | 57 | .152 |
|                                 | 2010         | .078                            | 46 | .200* | .980         | 46 | .616 |

\*. This is a lower bound of the true significance.

The second set of data, provided by WCED, presented both the NSC examination results of the Grade 12 learners from COSAT together with the NSC examination results of the Grade 12 learners of the comparison schools. The data violated the assumption of independence, which states that there should be no connection or dependence between data (Field, 2013). The scores in this data were interdependent since the same participants were measured in multiple variables. For example: the same learner wrote life science and mathematics in 2015. Thus when an ANOVA test is conducted on this data, it will produce a biased result (Field, 2013). To prevent the violation of this assumption a mean score for Life Science, Mathematics and Physical Science was calculated for each school for each academic year (Field, 2013). This mean score was used for all further ANOVA analysis. Table 7 shows the mean calculations which were used for the ANOVA analysis.

Table 7

*Mean calculation of COSAT and comparison schools, used for ANOVA.*

| School Name       | Year | Learners who passed at 50% mark (percentage) | NSC exam mark (percentage) |
|-------------------|------|--|----------------------------|
| Non-STEM School C | 2010 | 24.14  | 34.20                      |
|                   | 2011 | 16.25  | 31.00                      |
|                   | 2012 | 35.67  | 37.13                      |
|                   | 2013 | 22.18  | 36.23                      |
|                   | 2014 | 30.44  | 36.83                      |
|                   | 2015 | 21.31  | 33.10                      |
| Non-STEM School D | 2010 | 7.88   | 22.97                      |
|                   | 2011 | 6.14   | 22.87                      |
|                   | 2012 | 22.15  | 34.20                      |
|                   | 2013 | 28.93  | 37.90                      |
|                   | 2014 | 23.53  | 35.90                      |
|                   | 2015 | 16.59  | 34.57                      |
| STEM School A     | 2010 | 66.73  | 54.67                      |
|                   | 2011 | 63.91  | 55.77                      |
|                   | 2012 | 64.27  | 55.33                      |
|                   | 2013 | 66.49  | 54.20                      |
|                   | 2014 | 67.56  | 56.93                      |
|                   | 2015 | 63.80  | 55.43                      |
| STEM School B     | 2010 | - <sup>1</sup>                               | -                          |
|                   | 2011 | -  | -                          |
|                   | 2012 | -  | -                          |
|                   | 2013 | 74   | 55.35                      |
|                   | 2014 | 85.30  | 56.85                      |
|                   | 2015 | 75.47  | 63.30                      |
| COSAT             | 2010 | 82.61  | -                          |
|                   | 2011 | 73.81  | -                          |
|                   | 2012 | 68.97  | 54.83                      |
|                   | 2013 | 58.21  | 50.10                      |
|                   | 2014 | 57.33  | 49.43                      |
|                   | 2015 | 47.74  | 49.93                      |

<sup>1</sup> Data missing. Not available from WCED records.

### *Performance of COSAT learners in STEM subjects*

A desired outcome of the COSAT programme is a 100% pass rate of the enrolled Grade 12 learners (P. Cooper, February 22, 2016). Therefore, the statistical analysis focused on the NSC exam performance of the Grade 12 learners from COSAT. Descriptive statistics and ANOVA were used in the analysis and the results are presented below.

#### *Descriptive statistics of COSAT learners*

Descriptive statistics (see Table 8 on page 42) were used to show the mean and standard deviation of the performance of the Grade 12 learners in the NSC examination between 2010 and 2015. The performance of the Grade 12 learners in mathematics decreased from a mean score of 62.33% in 2010 to a mean score of 50.01% in 2015. Furthermore, the standard deviation of the mean increased from 12.71 to 16.78.

A similar trend can be seen for the Grade 12 performance in Life Science with the mean score decreasing from 70.98% in 2010 to 60.61% in 2015. Similarly, for Physical science, the mean score decreased from 55.28% in 2010 to 45.21% in 2015. While the Grade 12 performance in Information Technology shows a similar decline, with the mean decreasing from 56.33% in 2010 to 46.01% in 2015, there is inconsistency in this trend, specifically in 2013 where the mean score increases to 57.28%. Apart from information technology, it is evident that the Grade 12 performance in the NSC exams has declined between the period 2010 and 2015.

Table 8

*STEM subject final NSC examination results of Grade 12 learners*

|                                       | 2010  |       | 2012  |       | 2013  |       | 2014  |       | 2015  |       |
|---------------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                       | Mean  | SD*   | Mean  | SD*   | Mean  | SD*   | Mean  | SD*   | Mean  | SD*   |
| Mathematics<br>Mark (%)               | 62.33 | 12.71 | 59.60 | 16.99 | 59.91 | 16.65 | 51.12 | 16.14 | 50.01 | 16.78 |
| Information<br>Technology<br>Mark (%) | 56.33 | 7.89  | 49.77 | 12.58 | 57.38 | 14.25 | 46.71 | 12.55 | 46.01 | 12.42 |
| Life Science<br>Mark (%)              | 70.98 | 9.75  | 65.91 | 14.73 | 59.60 | 15.30 | 63.16 | 16.33 | 60.61 | 15.83 |
| Physical<br>Science<br>Mark (%)       | 55.28 | 16.87 | 51.79 | 19.55 | 46.23 | 17.95 | 46.34 | 16.99 | 45.21 | 14.66 |

\* Standard Deviation.

*One-Way Analysis of Variance*

A One-Way Analysis of Variance (ANOVA) was used to examine the decline in performance in STEM subjects by the COSAT learners between 2010 and 2015. The independent variable represented the year of the cohort, whilst the dependent variables represented achievement in Mathematics, Life Science, Physical Science and Information Technology. The *Levene's F* test revealed that the homogeneity of variance assumption was not met for the Life Sciences variable ( $p = .004$ ) and Information Technology variable ( $p = .009$ ). As such, the *Welch's F* test was used as an accurate result because the assumption of homogeneity of variance was violated (Field, 2013). Although the homogeneity of variance assumption was not violated with the Physical Science variable ( $p = .111$ ) and Mathematics variable ( $p = .314$ ), *Welch's F* test will be used for all variables.

There is a statistical difference in the means of the Mathematics mark, *Welch's F*(4, 154.056) = 9.098,  $p < .001$ ,  $\omega = .282$ , and Life Science Mark, *Welch's F*(4, 157.182) = 8.405,  $p < .001$ ,  $\omega = .219$ . Likewise, there is a statistically significant difference in the

means of the Physical Science Mark, Welch's  $F(4, 147.714) = 3.985, p = .004, \omega = .179$ , and Information Technology mark, Welch's  $F(4, 156.148) = 14.394, p > .001, \omega = .347$ . These results show that academic performance across the years was statistically different. The described decreasing trend in performance is further illustrated in Figure 3 which shows a decline in performance in mathematics, physical science and life science, while IT is seen to have inconsistent performance.

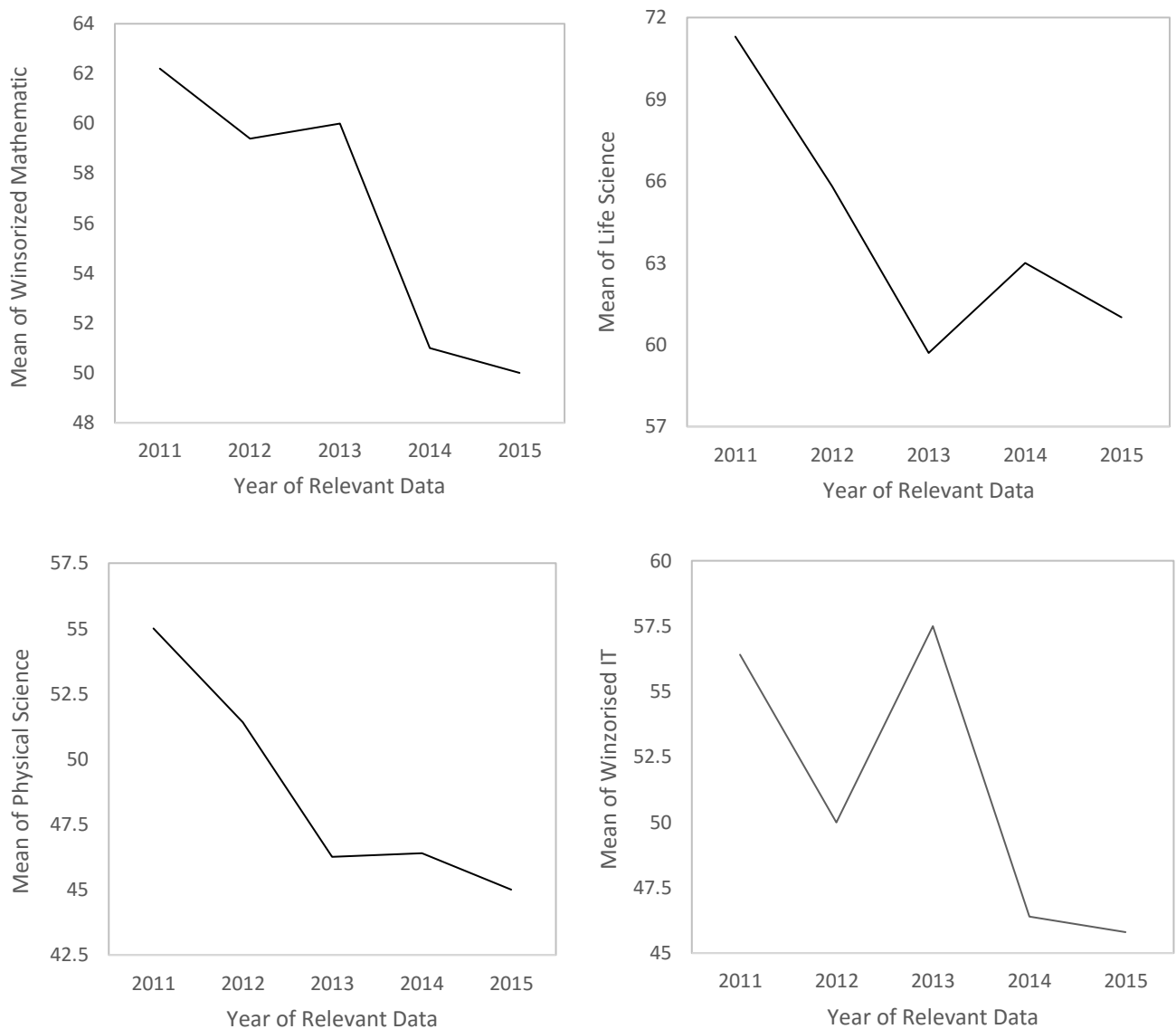


Figure 3. Mean Plots of STEM performance of Grade 12 learners during the years

#### *Promotion results of COSAT learners*

In analysing Grade 12 performance it is relevant to analyse the National Senior Certificate (NSC) promotion results as a measure of the learner's achievement. In the NSC there are three pass levels: (i) Higher Certificate pass (NSC/HC) – the learner

must obtain 40% in home language, 40% in two other subjects and 30% in three other subjects, (ii) Diploma pass (NSC/Dip) – the learner must obtain 40% for four high credit subjects including home language, (iii) Bachelors Pass (NSC/Bach) – the learner must obtain 40% for home language, 50% for four high credit subjects, and 30% for two other subjects. The high credit subject grouping includes all STEM subjects. For all the levels of promotion it is required to pass 6 of the 7 subjects taken.

In analysing the promotion results we can determine whether a COSAT alumni is likely to be accepted into a tertiary institution. A Bachelors pass qualifies a Grade 12 graduate access to any tertiary institution provided the individual meets the specific requirements for the degree or diploma. Figure 4 shows the count of the respective passes over the period 2010-2015.

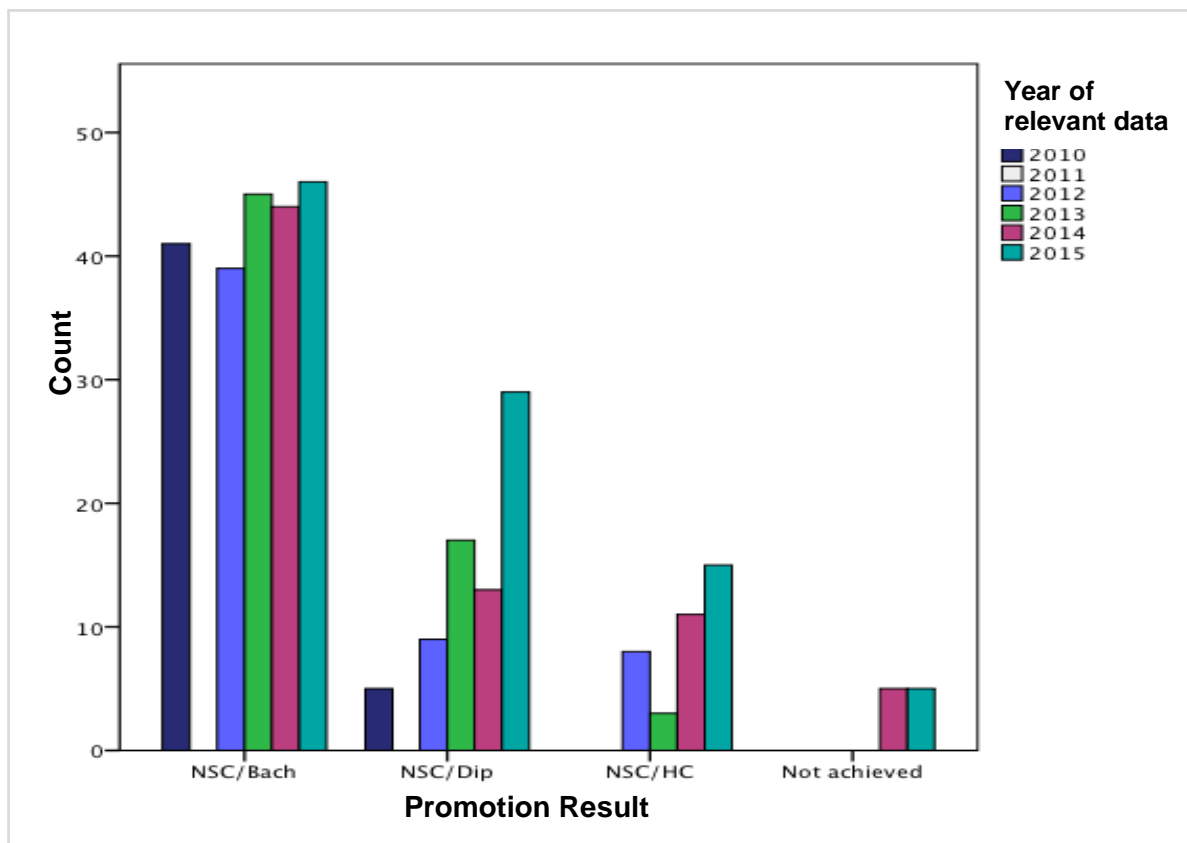


Figure 4. Promotion result of Grade 12 learners from 2010-2015

Figure 4 shows that between 2010 and 2013 COSAT achieved 100% pass rate while in 2014 the school achieved a 93.2% pass rate and in 2015 a 94.7% pass rate. Additionally, Figure 4 shows that there has been a slight increase in the count of Bachelor pass between 2010 and 2015 (shown as *NSC/Bach* on Figure 4). It is also

evident that there is an increase in the count of Diploma results (NSC/Dip), Higher Certificate results (HSC/HC) and an increase in the count of learners who did not achieve a promotion (shown as *not achieved* in Figure 4) between 2010 and 2015.

Table 9 presents the frequency and percentage of the promotion results of Grade 12 learners from 2010 to 2015. In 2010 89.1% of the COSAT Grade 12 learners received a bachelor pass and in 2015 48.4% of learners received a NSC Bachelor Pass. This shows a decline in the percentage of COSAT Grade 12 learners receiving bachelor passes.

Table 9  
*Promotion results of Grade 12s from 2010 to 2015*

| Year of relevant data | Pass classification | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------------------|---------------------|-----------|---------|---------------|--------------------|
| 2015                  | NSC/Bach            | 46        | 48.4    | 48.4          | 48.4               |
|                       | NSC/Dip             | 29        | 30.5    | 30.5          | 78.9               |
|                       | NSC/HC              | 15        | 15.8    | 15.8          | 94.7               |
|                       | Not promoted        | 5         | 5.3     | 5.3           | 100.0              |
| 2014                  | NSC/Bach            | 44        | 60.3    | 60.3          | 60.3               |
|                       | NSC/Dip             | 13        | 17.8    | 17.8          | 78.1               |
|                       | NSC/HC              | 11        | 15.1    | 15.1          | 93.2               |
|                       | Not promoted        | 5         | 6.8     | 6.8           | 100.0              |
| 2013                  | NSC/Bach            | 45        | 69.2    | 69.2          | 69.2               |
|                       | NSC/Dip             | 17        | 26.2    | 26.2          | 95.4               |
| 2012                  | NSC/Bach            | 39        | 67.2    | 69.6          | 69.6               |
|                       | NSC/Dip             | 9         | 15.5    | 16.1          | 85.7               |
|                       | NSC/HC              | 8         | 13.8    | 14.3          | 100.0              |
| 2010                  | NSC/Bach            | 41        | 89.1    | 89.1          | 89.1               |
|                       | NSC/Dip             | 5         | 10.9    | 10.9          | 100.0              |

*Performance of COSAT learners and comparison schools in STEM subjects*

The second analysis of learner performance, is to compare COSAT to four comparison schools: two STEM schools in the same region and two non-STEM schools within the same quintile and region. The data used for this analysis is Grade 12 academic performance in the National Senior Certificate for the period 2010 to 2015 and was provided by the Western Cape Department of Education. A summary of the data is available in Table 10.

Table 10

*Games Howell Post Hoc Analysis results: Comparison of mean percentage of learners who achieved above 50% (NSC)*

|       |                                   | Mean<br>Difference | Sig. | Bootstrap     |                 |                               |
|-------|-----------------------------------|--------------------|------|---------------|-----------------|-------------------------------|
|       |                                   |                    |      | Std.<br>Error | BCA<br>Interval | 95%<br>Confidence<br>Interval |
|       |                                   |                    |      | Lower         | Upper           |                               |
| COSAT | STEM<br>school A <sup>1</sup>     | 2.726              | .974 | 4.55008       | -6.83709        | 12.07476                      |
|       | STEM<br>school B <sup>1</sup>     | -10.071            | .501 | 5.46033       | -21.4410        | .07673                        |
|       | Non-STEM<br>school C <sup>2</sup> | 43.188             | .001 | 5.40658       | 32.61187        | 53.95338                      |
|       | Non-STEM<br>school D <sup>2</sup> | 50.649             | .000 | 5.76526       | 38.79232        | 62.33947                      |

<sup>1</sup> STEM School A and B are in the same region and follow a similar STEM curriculum to COSAT but differentiate in school quintile allocation.

<sup>2</sup> Non-STEM School C and B are in the same region and have the same school quintile allocation but differentiate in the STEM curriculum focus, both non-STEM schools follow the traditional CAPS curriculum.

A One-Way Analysis of Variance (ANOVA) was used to examine the question of STEM performance of COSAT compared to two non-STEM schools and two STEM schools. In the first comparison, the independent variable represented the percentage of learners who passed at 50%, whilst the dependent variable represented the school. The *Levene's F* test revealed that the homogeneity of variance assumption was

violated ( $p = .041$ ), therefore the *Welch F* test was used as an accurate result (Field, 2013).

The analysis showed that there is a significant difference between the schools in terms of the percentage of learners who passed at or above a 50% score, Welch's  $F(4, 7.387) = 71.231$ ,  $p > .001$ ,  $\omega = .954$ . The  $p$  value indicates that there is variance between the groups in terms of percentage of learners who pass at the 50% level. A Post Hoc test using the *Games Howell* test did not show a significant difference between COSAT and STEM School A ( $p = .974$ ) or STEM School B ( $p = .501$ ). Additionally, a Post Hoc test using the *Games Howell* test did show a significant difference between COSAT and non-STEM school C ( $p = .001$ ) and non-STEM school D ( $p > .001$ ). Table 10 shows the results for the Games Howell Post Hoc Test.

An additional ANOVA test was used to assess average percentage of the final NSC exam mark. The independent variable represented the mean percentage of the exam mark, whilst the dependent variable represented the school.

The *Levene's F* test revealed that the homogeneity of variance assumption was not met ( $p < .000$ ) and so the *Welch's F* test was used. There is a statistical difference between the school groups in terms of the mean percentage exam mark, Welch's  $F(4, 6.174) = 84.042$ ,  $p < .001$ ,  $\omega = .94$ . Further indicating that there is variance in academic performance between the groups, particularly in terms of mean percentage of exam mark. A Post Hoc test using *Games-Howell* did not show a significant difference in terms of mean percentage mark between COSAT and STEM School A ( $p = .393$ ) or STEM School B ( $p = .300$ ), but did show a significant difference between COSAT and non-STEM school C ( $p = .009$ ) and non-STEM school D ( $p = .003$ ). Table 11 shows the results for the Games Howell Post Hoc Test.

Table 11

*Games Howell Post Hoc Analysis results: Comparison of mean of NSC final exam*

|       |                                   | Mean<br>Difference | Sig. | Std.<br>Error | Bootstrap       |                   |
|-------|-----------------------------------|--------------------|------|---------------|-----------------|-------------------|
|       |                                   |                    |      |               | BCA<br>Interval | 95%<br>Confidence |
|       |                                   |                    |      |               | Lower           | Upper             |
| COSAT | STEM<br>school A <sup>1</sup>     | -3.935             | .393 | 1.41935       | -6.2178         | -.6869            |
|       | STEM<br>school B <sup>1</sup>     | -7.047             | .300 | 2.2850        | -11.3850        | -2.8850           |
|       | Non-STEM<br>school C <sup>2</sup> | 16.705             | .009 | 1.6953        | 13.6562         | 20.4940           |
|       | Non-STEM<br>school D <sup>2</sup> | 20.052             | .003 | 2.9799        | 14.3336         | 26.2499           |

<sup>1</sup> STEM School A and B are in the same region and follow a similar STEM curriculum to COSAT but differentiate in school quintile allocation.

<sup>2</sup> Non-STEM School C and B are in the same region and have the same school quintile allocation but differentiate in the STEM curriculum focus, both non-STEM schools follow the traditional CAPS curriculum.

To summarize the presented data, there appears to be no significant difference in the mean exam mark of the NSC final exam and the mean number of learners passing above 50% between COSAT and STEM school A and B. In other words, when comparing COSAT with the comparison schools that follow the same curriculum and are in the same region, but differ in the quintile allocation, there is no significant difference in the mean marks of the NSC final exam and the numbers of learners passing above the 50% mark.

When comparing COSAT to schools that are in the same region and have the same quintile allocation but differ in the curriculum followed, i.e. non-STEM School C and non-STEM school D, there is a significant difference in the mean marks of the NSC final exam and the number of learners passing above the 50% mark. This difference is further illustrated in figure 5.

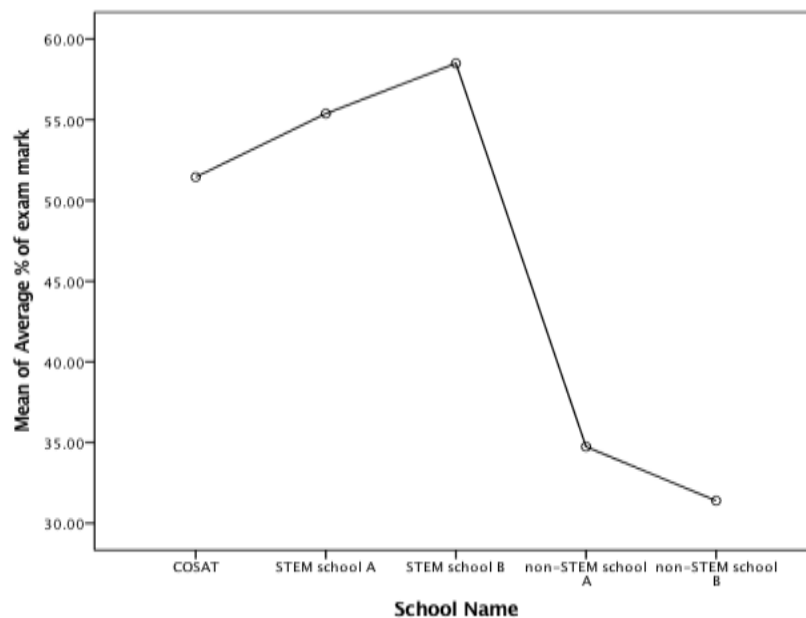
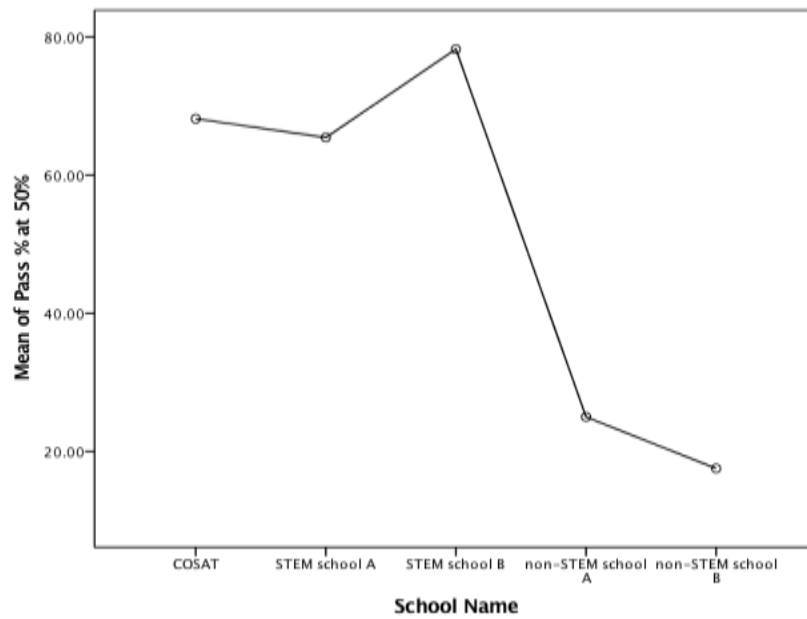


Figure 5. Mean plots of COSAT and comparison schools

**To what extent does the COSAT programme effectively improve the retention of low-income, black youth in STEM disciplines?**

Of the 96 completed responses, 96.9% of the sample had enrolled in an institute of higher learning since leaving COSAT, see Table 12. Of the 96.9% who had enrolled, 63.4% are currently enrolled at a tertiary institution and 36.6% had already graduated from a tertiary institution.

Table 12

*Survey question: Have you enrolled in an institute of higher learning since leaving COSAT?*

|       |       | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------|-----------|---------|---------------|--------------------|
| Valid | Yes   | 93        | 96.9    | 96.9          | 96.9               |
|       | No    | 3         | 3.1     | 3.1           | 100.0              |
|       | Total | 96        | 100.0   | 100.0         |                    |

Of those currently enrolled at a tertiary institute (n=59), 25.4% are pursuing a qualification in the sciences, 6.8% are pursuing a qualification in the field of technology, 18.6% are pursuing a qualification in engineering, and 1.7% are pursuing degrees in Mathematics. A large portion of the respondents, 47.5%, are pursuing other degrees, including 10.2% who are pursuing BCom degrees.

A total of 52.5% of the respondents who are currently enrolled in an institute of higher learning are pursuing a STEM qualification, see Table 13. Of those who responded that they have already graduated (n=33), 21.2% graduated with a degree in the sciences, 27.3% graduated with a degree in technology, 12.1% graduated with degrees in engineering and 3% graduated with degrees in mathematics. Therefore, a total of 63.6% of those who had already graduated, graduated with a degree in a STEM field while 36.4% of the respondents graduated with degrees in other fields such as business or economics.

Table 13

*Classification of survey respondent's degree type*

|       |             | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|-------------|-----------|---------|---------------|--------------------|
| Valid | Science     | 15        | 25.4    | 25.4          | 25.4               |
|       | Technology  | 4         | 6.8     | 6.8           | 32.2               |
|       | Engineering | 11        | 18.6    | 18.6          | 50.8               |
|       | Mathematics | 1         | 1.7     | 1.7           | 52.5               |
|       | Other       | 28        | 47.5    | 47.5          | 100.0              |
|       | Total       | 59        | 100     | 100.0         |                    |

A second component of analysing the post school activities of the COSAT alumni was to assess the respondents' employment patterns. For the respondents who have

enrolled at an institute of higher learning since graduating from COSAT (n=33), 49.5% are currently full time students, 37.6% are currently employed full time, 7.5% are employed part time and 5.4% are occupied with other activities, see Table 14. Of those currently employed (n=8), 37.5% of the respondents are employed by a computer information systems or computer technology company, 37.5% are employed by an engineering (mechanical, chemical, etc.) company, and 12.5% work within the food industry.

Table 14  
*Employment status of participants*

|  | Frequency | Percent | Valid Percent | Cumulative Percent |
|--|-----------|---------|---------------|--------------------|
| Yes, I am currently employed full time.            | 35        | 37.6    | 37.6          | 37.6               |
| Yes, I am currently employed part time             | 7         | 7.5     | 7.5           | 45.2               |
| No, I am currently occupied with other activities. | 5         | 5.4     | 5.4           | 50.4               |
| No, I am currently a full-time student             | 46        | 49.5    | 49.5          | 100.0              |
| Total  | 93        | 100     | 100           |                    |

Of those currently employed (n=35), 71.9% of the respondents stated that their position is related to their field or specialization, 22.9% stated that it was similar to their field or specialization, and 5.7% stated that their current position was not related to their field or specialization. See Table 15

Table 15

*Survey Question: Is your current position related to your field of study?*

|  | Frequency | Percent | Valid Percent | Cumulative Percent |
|--|-----------|---------|---------------|--------------------|
| Yes, same field as degree or specialization      | 25        | 71.4    | 71.4          | 71.4               |
| Yes, similar field as degree or specialization   | 8         | 22.9    | 22.9          | 94.3               |
| No, different field to degree or specialization. | 2         | 5.7     | 5.7           | 100.0              |
| Total  | 35        | 100.0   | 100.0         |                    |

Analysis of the participants decision to pursue their specific degree or qualification indicated four key influencing factors. Each respondent was given the option to select more than one response. The four highest influences for all respondents who had enrolled in an institute of higher learning (n= 93) were interest in the specific field, ambition to contribute to society, not accepted for first degree choice and the wealth that the profession provides, see Table 16.

Table 16

*Influencers on decision in specialization choice*

|  | Valid percentage |
|--|------------------|
| Interest in the specific field                   | 76.3             |
| Ambition to contribute to society                | 25.8             |
| Not accepted for first degree choice             | 10.8             |
| The profession provides wealth                   | 9.7              |
| The profession provides prestige                 | 7.5              |
| Family encouragement to pursue a specific degree | 5.4              |
| Received funding for a specific degree           | 5.4              |
| Family pressure to pursue specific degree        | 1.1              |

For respondents who had enrolled in a STEM tertiary degree (n = 31) or had graduated with a STEM tertiary degree (n = 21) the results were slightly different. The four highest influences were interest in the specific field, ambition to contribute to society, the

profession provides prestige and family encouragement to pursue a specific degree, see Table 17.

Table 17

*Influencers on decision in specialization choice of STEM students or graduates*

|  | Valid percentage |
|--|------------------|
| Interest in the specific field                   | 78.8             |
| Ambition to contribute to society                | 34.6             |
| The profession provides prestige                 | 9.6              |
| Family encouragement to pursue a specific degree | 9.6              |
| The profession provides wealth                   | 7.7              |
| Not accepted for first degree choice             | 5.8              |
| Received funding for a specific degree           | 3.8              |
| Family pressure to pursue specific degree        | 1.9              |

To answer the two evaluation questions the results of the analysis will be discussed in the next chapter.

## Chapter 4

The purpose of this chapter is to discuss the results of the analysis in the context of contemporary research to draw conclusions about the COSAT programme logic. The chapter will include a discussion of the limitations of the two aspects of the evaluation and recommendations for future research.

### **COSAT learners have increased academic performance compared to learners who did not attend STEM schools**

#### *The performance of COSAT learners*

The analysis revealed that performance of COSAT learners, specifically the performance of Grade 12 learners in the final NSC examinations in mathematics, physical science and life science have dropped over the period 2010 to 2015. Further analysis, revealed that the difference between the marks over the years was statistically significant. This means the results did not weaken by a chance fluctuation but rather that there is a contributing cause to the decline in performance.

The school administration has suggested that the decline of the learner's results is partly due to the influence of the increased demand and requirement to grow the student body (P. Cooper, personal communication, November 9, 2016). While the minimum requirement for admission remains at 60%, many learners are accepted who fall well below the requirements. The increased admission of low performance learner's places pressure on the COSAT programme and its activities which benefit at-risk learners.

The influence of increased student numbers is evident in the promotion results of the Grade 12 learners of COSAT over the period 2010 to 2015. There was an increase in the number of learners who have received a bachelor pass, diploma pass or higher certificate pass, but this can be attributed to an increase in learner numbers rather than an increase in learner performance. The analysis further revealed that the percentage of Grade 12 learners who received bachelor passes has decreased over the period 2010 to 2015. There may be other factors but this evidence suggests that one of the primary contributing factors increased learner numbers. Although the

number of graduates exiting COSAT is increasing, the percentage of graduates receiving bachelor's passes is declining.

COSAT's education support activities which focus on at-risk learners are limited to an extended school day, with a study hour at the end of the day, and Saturday classes, which are provided by external teachers. It is evident that there are more opportunities and curriculum support (such as AP Mathematics and Robotics Curriculum) for advanced learners. The presented evidence highlights that the activities which focus on at-risk learners are not having the necessary impact. Contemporary literature has shown that while prior achievement and intelligence predict the greatest variance in mathematics achievement, motivation is a significant mediator (Kriegbaum et al., 2015; Kriegbaum & Spinath, 2016). When learners are self-motivated or have self-regulatory learning behaviours they have improved or advanced mathematic achievement. One predictor of self-regulated learning is a supportive and responsive teacher and learning environment (Leon et al., 2015). Literature has shown that the strongest correlations for student achievement in mathematics are found to be teacher preparation and teacher certification (Darling-Hammond, 2000).

A second contributing factor could be communication between parent and child which is an opportunity for discussion about high expectations of academic performance and consistent encouragement. These two forms of communication or practices are found to positively affect academic experiences of secondary school learners (Catsambis, 2001; Jeynes, 2003).

Research has shown that learners who enter STEM-focused schools without meeting pre-specified requirements can successfully graduate (Scott, 2012). At-risk learners of COSAT need to have an excellent learning environment and benefit from the best teachers. Programmes which focus on enhancing self-motivation and self-regulatory learning behaviors should be implemented to gain increased learner success. Additionally, while COSAT encourages parental involvement through regular feedback reports and parent-teacher meetings, more room could be given to activities which educate parents on the importance of encouragement in communication for learner success.

### *COSAT performance comparable to better resourced STEM-focused schools*

Analysis of COSAT learner performance in the National Senior Certificate exams over the period 2010 to 2015 revealed that COSAT's performance is not significantly different from comparison schools which are in the same region and curriculum but differ in quintile allocation. The lack of significance means that the difference between COSAT and these comparison schools did not have a contributing cause but rather that it was a high probability that it was caused by chance. This is evidence that COSAT's programme is achieving similar results to better resourced schools. This is a significant finding in the context of South Africa's education system which is characterised by unequal access to quality education, poor academic performance and low participation in science and mathematics (Reddy et al., 2012; Spaul, 2013). South Africa's top performing learners are characteristically found in well-resourced, previously categorized 'former house of assembly' or white schools with poor achievement being correlated with under-resourced schools (Reddy et al., 2012).

The learners who attend COSAT come from a community which is considered a low-income and under-educated community (City of Cape Town, 2013). While generally poor academic achievement is correlated with under-resourced schools and communities, COSAT has produced competitive academic achievement in this context.

### *COSAT out-performs non-STEM focused schools*

Analysis of COSAT learner performance in the National Senior Certificate exams over the period 2010 to 2015 revealed that COSAT's performance is significantly better from schools who are in the same region and quintile allocation but who do not share the same curriculum. This means that the difference did not occur by chance but rather that there was a contributing cause. It can therefore be assumed that because the schools matched in terms of quintile allocation and region that the contributing cause may be the curriculum.

Although the design of the research does not allow for the inference of robust causal inferences, it can be suggested that the STEM curriculum provided by COSAT has

produced better academic results for STEM subjects than the curriculum provided by non-STEM schools. Research has provided evidence that STEM-focused schools can provide advanced support for learners, regardless of prior academic achievement, causing learners to graduate above graduation requirements (Scott, 2012). Additionally, learners who attend STEM focused schools are more interested in STEM subjects and perform better in mathematics and science assessments (Erdogan & Stuessy, 2015).

Research is readily available showing the success of STEM education in other countries, however very little is known about the success of STEM-focused schools in South Africa. This research provides evidence in support of STEM-focused schools in a South African context. This is a significant finding for The South African Department of Education and the *National Strategy for Mathematics, Science and Technology Education* (DOE, 2011). South African youth face multiple and continuous barriers in their pursuit of educational success. The *National Strategy for Mathematics, Science and Technology* suggest STEM-focused schools as interventions to address poor STEM performance of secondary school learners and increase participation and performance in mathematics and physical science (DOE, 2011). This research shows that STEM-focused schools could be a successful intervention in addressing some of the educational barriers facing South Africa's learners.

The logic of a STEM-focused school is to provide courses focused on STEM content and application with electives and/or internship opportunities which provide real-world problem solving opportunities to increase performance in STEM disciplines (Scott, 2012). This is the logic that COSAT's programme is modelled on.

COSAT's educational support activities provide only STEM-focused subjects, this is a limited selection of subjects compared to the comparison schools in the study. Additionally, COSAT provides electives, such as Robotics and AP Mathematics, which provide real world problem solving opportunities to learners (P. Cooper, personal communication, February 22, 2016). However, these electives have limited reach. AP Mathematics is offered to high achieving learners only, which means very few learners have access to the elective. Also, the Robotics curriculum is offered to Grade 8s and 9s only. While this research has provided evidence in support of the success of

COSAT's education model, additional electives which provide real-world problem solving opportunities for learners could result in greater success.

In conclusion, the analysis demonstrates that while the performance of COSAT learners, in the Mathematics, Science and Life Science NSC examinations, have declined over the period 2010 to 2015, COSAT learner performance remains significantly better than comparison schools which are similarly resourced but do not follow a STEM curriculum.

### **COSAT programme effectively improves the retention of low-income, black youth in STEM disciplines**

#### *COSAT alumni participating in STEM discipline*

COSAT's long term outcome is the improved retention of low-income, black students in STEM disciplines. The analysis revealed that a large percentage of COSAT learners have enrolled in an institute of higher learning since leaving COSAT and additionally that more than half of these learners are pursuing or have obtained a STEM qualification. Additionally, a sizable percentage of the COSAT alumni are employed in a field which is related to their degree, field of study, or specialization. Consequently, we can assume that if a large percentage of the COSAT alumni are completing or have completed STEM degrees then it should follow that many alumni are pursuing a STEM related occupation.

It is evident that COSAT's alumni are participating in STEM disciplines in tertiary education as well as in employment. This evaluation can show that COSAT has achieved its longer-term outcome and has been successful in achieving its intended impact. COSAT has effectively improved the retention of low-income, black youth in STEM disciplines. COSAT's programme logic of combining quality education and parental involvement activities is effective.

Contemporary research assessing the college and career readiness of learners showed that learners who attend STEM-focused schools are more willing to attend class and are more likely to earn a college degree (Erdogan & Stuessy, 2015).

Additionally, the percentage of tertiary education graduates majoring in STEM related fields is greater in STEM-focused schools than in traditional schools (Tai et al., 2011). This evaluation of COSAT shows comparable results and is further evidence of the success of STEM schools.

The aim of a STEM learning policy is to improve secondary schooling performance in STEM subjects to improve country wide research output, job performance and innovation in STEM (Ernst & Glennie, 2015). Very little is known about the long-term success of STEM-focused secondary schools in South Africa and this evaluation can hopefully contribute to this lack of research. The long-term impact of COSAT is therefore significant and is further evidence in support of the STEM school initiative identified in the The South African Department of Education's *National Strategy for Mathematics, Science and Technology Education*. This research provides evidence of a relationship between a STEM school initiative and greater academic and employment activity in the STEM field.

#### *Interest is a key influencer in STEM degree choice*

There are various influencers which contribute to the degree or occupation choice of the COSAT alumni. Contemporary research has suggested the importance of familial influence, educator influence and the influence of financial capital in the selection of a degree major (Dick & Rallis, 1991; Kruse et al., 2015; Moore, 2006; Wang, 2013). In the context of STEM however, a key influencer is interest in STEM. Research has shown that attainment of a STEM degree, when enrolled in a STEM degree, has been mediated by the influence of interest in STEM subjects (Erdogan & Stuessy, 2015; Tai et al., 2011).

This evaluation provides comparable findings. The influencers which contributed most to the participant's specialization choice were: interest in the specific field, ambition to contribute to society, were not accepted for the first-degree choice and the profession provides wealth and prestige. Pointedly, interest and achievement were not separated as options in this survey and therefore interest could also be understood in terms of achievement or success in the subject. Wang (2013) showed that math achievement and self-efficacy beliefs influenced the outcome of pursuing a STEM degree. Perhaps

it could be deduced that the influence of interest could be extended to include success, and contemporary research would support this.

### **Recommendations for the COSAT programme**

Based on these findings, the following recommendations are presented:

1. The presented evidence highlights that the activities which focus on at-risk learners are not having the necessary impact. Programmes which focus on enhancing self-motivation and self-regulatory learning behaviors should be implemented to gain increased learner success. Additionally, more room could be given to activities which educate parents on the importance of encouragement in communication for learner success.
2. While COSAT's educational activities have shown to be successful additional electives, which provide real-world problem solving opportunities for learners, could result in greater success. Electives such as AP Mathematics and the Robotics curriculum should be added to and expanded to be more inclusive of additional learners.

### **Limitations and recommendations for future evaluation research**

While this research has produced significant findings, the results should be interpreted with care. This research did not use randomly assigned participants. The participants of the study were made up of the COSAT beneficiaries as well as a comparison group which matched COSAT on region, assigned quintile or STEM-focused curriculum. Therefore, confounding variables may have contributed to the results of the study. In other words, the success of the COSAT programme cannot be solely attributed to the programme but attention should also be drawn to various factors; these will be discussed below.

Firstly, the comparison groups' characteristics are a limitation to the study. While the groups were matched based on quintile, region or STEM curriculum, it is impossible to create equal groups without using randomized sampling. Therefore, the groups had clear differences; the biggest of which is the number of learners in each school. The two schools which matched with COSAT on region and quintile, but differed in curriculum, had a larger student body. While the student-to-teacher ratio of COSAT

and the comparison schools were similar, there are many other variables which correlate with large student bodies which cannot be controlled for. Therefore, the variances between the comparison group and COSAT could bias the results.

For this study, all programme participants were included in the study and therefore consideration should be given to how the participants are selected into the programme. Since the learners are enrolled based on prior academic performance, it can be assumed that the academic performance of the COSAT learner was already higher than learners in the comparison group. Thus, the occurrence of selection bias may influence the findings of this study. Selection bias ensues when the way the participant is selected to take part in the study biases the actual results of the research (Rossi et al., 2004).

For the second part of the evaluation, a survey method and not a controlled group design was used; because control and comparison groups were not used no correlations or causality can be deduced in this analysis. The presence of confounding variables, such as selection bias, should be acknowledged. The method of electronic survey could have influenced the results of the survey by targeting participants with affordable or free internet, such as university students or employed persons.

The limitations discussed emphasize that it is impossible to determine whether the success of the COSAT programme is limited to the programme activities or whether confounding variables have influenced the results.

Based on these limitations, the following recommendations are presented:

1. COSAT has recently implemented an entrance examination as part of the selection process. It is recommended that the format of the entrance examination replicate the Grade 8 end of year examination. This will provide a standardized baseline assessment and post-test assessment for yearly evaluations of learners. This will inform a more accurate analysis of the learners, specific analysis of the performance of the Grade 8 learners and the impact of the early academic support programmes could be completed.

2. It is suggested that COSAT attempt to keep an updated alumnus monitoring system. This would allow for future evaluations to monitor the activities of the alumni more comprehensively. If more of the COSAT alumni could be included as participants in the evaluation, the result will be a stronger evaluation.
3. Future research which expands on this research could provide valuable insight for The South African Department of Education's *National Strategy for Mathematics, Science and Technology Education*. Research should focus on other STEM-focused secondary schools as well as the long-term impact of these schools. This could provide further evidence in support of the STEM school initiative.

## **Conclusion**

In conclusion, this evaluation has shown the intermediate and long-term impact of COSAT. COSAT learners have increased STEM knowledge and academic performance compared to learners from non-STEM schools. Moreover, COSAT has effectively improved the retention of low-income, black youth in STEM disciplines. This evaluation has provided evidence, in a South African context, in support of the STEM school initiative identified in the The South African Department of Education's *National Strategy for Mathematics, Science and Technology Education*.

To counteract the influence of increased learner numbers on COSAT's success, COSAT's education activities should be expanded to include support activities for at-risk learners which focus on enhancing self-motivation and self-regulatory learning behaviours. To encourage greater STEM participation additional electives which provide greater opportunity for real-life application of STEM knowledge should be introduced. Finally, activities which educate parents on the importance of encouragement in communication would positively contribute to learner success.

Future evaluations of COSAT should be completed to gain greater insight into the impact of academic support programmes for at-risk learners, and to evaluate the impact of the newly implemented psychosocial and teacher development activities. Evaluations of additional STEM-focused schools should be completed to gain further understanding of the role of STEM in South Africa.

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## APPENDIX A

### Example of secondary data provided by COSAT

|    | Participant | Year | Grade    | Home_Lang | First_Add_Lang | Mathematics | Life_Orienati... | Info_Tech | Life_Science | Phys_Science | Promotion    |
|----|-------------|------|----------|-----------|----------------|-------------|------------------|-----------|--------------|--------------|--------------|
| 1  | 1001        | 2015 | Grade 12 | 79        | 83             | 42          | 61               | 47        | 65           | 41           | NSC/Dip      |
| 2  | 1002        | 2015 | Grade 12 | 66        | 69             | 26          | 60               | 33        | 51           | 24           | Not achieved |
| 3  | 1003        | 2015 | Grade 12 | 69        | 67             | 39          | 68               | 42        | 57           | 36           | NSC/Dip      |
| 4  | 1004        | 2015 | Grade 12 | 74        | 75             | 46          | 67               | 40        | 55           | 33           | NSC/Dip      |
| 5  | 1005        | 2015 | Grade 12 | 75        | 64             | 59          | 65               | 37        | 65           | 37           | NSC/Bach     |
| 6  | 1006        | 2015 | Grade 12 | 76        | 70             | 38          | 63               | 41        | 56           | 36           | NSC/Dip      |
| 7  | 1007        | 2015 | Grade 12 | 73        | 81             | 56          | 65               | 59        | 61           | 51           | NSC/Bach     |
| 8  | 1008        | 2015 | Grade 12 | 75        | 84             | 96          | 79               | 79        | 92           | 87           | NSC/Bach     |
| 9  | 1009        | 2015 | Grade 12 | 63        | 64             | 23          | 52               | 34        | 37           | 26           | Not achieved |
| 10 | 1010        | 2015 | Grade 12 | 72        | 56             | 47          | 53               | 29        | 36           | 38           | NSC/HC       |
| 11 | 1011        | 2015 | Grade 12 | 74        | 65             | 57          | 65               | 62        | 76           | 51           | NSC/Bach     |
| 12 | 1012        | 2015 | Grade 12 | 70        | 67             | 29          | 62               | 43        | 51           | 34           | NSC/Dip      |
| 13 | 1013        | 2015 | Grade 12 | 63        | 45             | 27          | 47               | 32        | 32           | 23           | Not achieved |
| 14 | 1014        | 2015 | Grade 12 | 64        | 55             | 18          | 52               | 25        | 31           | 18           | Not achieved |
| 15 | 1015        | 2015 | Grade 12 | 78        | 70             | 35          | 69               | 39        | 62           | 36           | NSC/HC       |
| 16 | 1016        | 2015 | Grade 12 | 70        | 70             | 58          | 57               | 39        | 61           | 43           | NSC/Bach     |
| 17 | 1017        | 2015 | Grade 12 | 78        | 82             | 49          | 75               | 48        | 65           | 46           | NSC/Dip      |
| 18 | 1018        | 2015 | Grade 12 | 81        | 82             | 87          | 75               | 85        | 89           | 80           | NSC/Bach     |
| 19 | 1019        | 2015 | Grade 12 | 71        | 64             | 55          | 63               | 45        | 56           | 46           | NSC/Bach     |
| 20 | 1020        | 2015 | Grade 12 | 74        | 63             | 50          | 60               | 37        | 44           | 37           | NSC/Dip      |
| 21 | 1021        | 2015 | Grade 12 | 84        | 80             | 62          | 70               | 65        | 79           | 59           | NSC/Bach     |
| 22 | 1022        | 2015 | Grade 12 | 71        | 54             | 32          | 54               | 28        | 42           | 34           | NSC/HC       |
| 23 | 1023        | 2015 | Grade 12 | 63        | 61             | 64          | 52               | 48        | 71           | 54           | NSC/Bach     |

## APPENDIX B

### Secondary DATA provided by WCED

| Year | School            | Life Science               |                 |                                 | Mathematics                |              |                                 | Physical Science           |              |                                 |
|------|-------------------|----------------------------|-----------------|---------------------------------|----------------------------|--------------|---------------------------------|----------------------------|--------------|---------------------------------|
|      |                   | Pass %<br>at 50%<br>(Exam) | Average<br>%    | Average<br>% of<br>Exam<br>Mark | Pass %<br>at 50%<br>(Exam) | Average<br>% | Average<br>% of<br>Exam<br>Mark | Pass %<br>at 50%<br>(Exam) | Average<br>% | Average<br>% of<br>Exam<br>Mark |
| 2010 | <b>COSAT</b>      | <b>100</b>                 | -- <sup>a</sup> | --                              | <b>84.78</b>               | --           | --                              | <b>63.04</b>               | --           | --                              |
|      | STEM School A     | 88.76                      | 64.5            | 62.1                            | 60                         | 52.3         | 59.6                            | 51.43                      | 52           | 49.6                            |
|      | STEM School B     | --                         | --              | --                              | --                         | --           | --                              | --                         | --           | --                              |
|      | Non-STEM School C | 41.46                      | 45.4            | 41.2                            | 18.75                      | 39           | 34.8                            | 12.2                       | 31.1         | 26.6                            |
|      | Non-STEM school D | 19.64                      | 35.6            | 32.7                            | 3.01                       | 18.8         | 16.4                            | 0.98                       | 22.5         | 19.8                            |
| 2011 | <b>COSAT</b>      | <b>68</b>                  | --              | --                              | <b>68.57</b>               | --           | --                              | <b>55.71</b>               | --           | --                              |
|      | STEM School A     | 83.95                      | 64.5            | 61.7                            | 52.22                      | 53.9         | 51.9                            | 55.56                      | 55.8         | 53.7                            |
|      | STEM School B     | --                         | --              | --                              | --                         | --           | --                              | --                         | --           | --                              |
|      | Non-STEM School C | 12.82                      | 38.1            | 34.3                            | 32.14                      | 41.7         | 38                              | 3.8                        | 24           | 20.7                            |
|      | Non-STEM school D | 7.79                       | 32.8            | 29.6                            | 5.56                       | 22.6         | 20.2                            | 5.08                       | 20.8         | 18.8                            |
| 2012 | <b>COSAT</b>      | <b>82.76</b>               | <b>65.9</b>     | <b>61.5</b>                     | <b>70.69</b>               | <b>59.6</b>  | <b>54.8</b>                     | <b>53.45</b>               | <b>51.8</b>  | <b>48.2</b>                     |
|      | STEM School A     | 85.11                      | 67.6            | 64.9                            | 49.57                      | 52.3         | 49.8                            | 58.12                      | 53.18        | 51.3                            |
|      | STEM School B     | --                         | --              | --                              | --                         | --           | --                              | --                         | --           | --                              |

|      |                   |              |             |             |              |             |             |              |             |             |
|------|-------------------|--------------|-------------|-------------|--------------|-------------|-------------|--------------|-------------|-------------|
|      | Non-STEM School C | 16.67        | 34.8        | 30.6        | 55.56        | 49.3        | 44.4        | 34.78        | 40.4        | 36.4        |
|      | Non-STEM school D | 28.17        | 44.7        | 40.4        | 21.21        | 37.4        | 33.1        | 17.07        | 32.1        | 29.1        |
| 2013 | <b>COSAT</b>      | <b>68.66</b> | <b>58.9</b> | <b>54.9</b> | <b>68.66</b> | <b>59</b>   | <b>53.7</b> | <b>37.31</b> | <b>45.4</b> | <b>41.7</b> |
|      | STEM School A     | 85.47        | 63.2        | 60.9        | 63.64        | 55.4        | 53.2        | 50.35        | 51.1        | 48.5        |
|      | STEM School B     | --           | --          | --          | 84           | 58.3        | 56.2        | 64           | 56.4        | 54.5        |
|      | Non-STEM School C | 17.86        | 37.7        | 34.3        | 19.51        | 40.7        | 36.4        | 29.17        | 42.4        | 38          |
|      | Non-STEM school D | 28.21        | 44.2        | 40.3        | 28.57        | 42.5        | 38.5        | 8.57         | 30.3        | 27.5        |
| 2014 | <b>COSAT</b>      | <b>74.67</b> | <b>62.4</b> | <b>58.8</b> | <b>52</b>    | <b>50.9</b> | <b>46.6</b> | <b>45.33</b> | <b>45.8</b> | <b>42.9</b> |
|      | STEM School A     | 89.47        | 68.4        | 66.9        | 63.21        | 56.4        | 54.5        | 50           | 51.9        | 49.4        |
|      | STEM School B     | --           | --          | --          | 94.12        | 59.8        | 58.5        | 76.47        | 56.4        | 55.2        |
|      | Non-STEM School C | 42.59        | 46.2        | 42.7        | 25.64        | 37.6        | 33.9        | 23.08        | 37.2        | 33.9        |
|      | Non-STEM school D | 19.81        | 36.5        | 33.8        | 28.57        | 42.5        | 38.5        | 22.2         | 38.2        | 35.4        |
| 2015 | <b>COSAT</b>      | 62.34        | 62          | 59          | 47.06        | 51.2        | 47.3        | 33.82        | 46.7        | 43.5        |
|      | STEM School A     | 84.62        | 68.3        | 66.8        | 60.15        | 55.2        | 52.6        | 46.62        | 49.5        | 46.9        |
|      | STEM School B     | 91.53        | 70.4        | 69.1        | 68.6         | 62.2        | 60.5        | 66.27        | 61.4        | 60.3        |
|      | Non-STEM School C | 12.94        | 33.6        | 31.1        | 33.33        | 42.1        | 38.4        | 17.65        | 32.6        | 29.8        |
|      | Non-STEM school D | 24.26        | 43.1        | 40.5        | 14.04        | 36.2        | 33.9        | 11.48        | 31.5        | 29.3        |

<sup>a</sup> Missing information from WCED records.

## **Appendix C**

### **Centre of Science and Technology Alumni Survey**



We are trying to find out what the alumni of the Centre of Science and Technology (COSAT) are currently engaged in. The data will contribute towards a master's research project as well as COSAT's alumni monitoring.

Please note that the University of Cape Town's Commerce Faculty Ethics in Research Committee has approved this research.

The questionnaire will take approximately 10 minutes to complete. Your participation in this research is voluntary and confidential. You can choose to withdraw from the research at any time.

Due to the nature of the study you will need to provide the researchers with some identifying information. This is required to ensure that only COSAT alumni participate in this study to maintain its integrity and ultimate value. However, all responses will be confidential and used for the purposes of this research only. During analysis identifiers will be stripped and no data will be matched to specific individuals.

To encourage your participation, I am offering an incentive of a lucky draw of two R750 vouchers. The final question of the survey invites you to enter a contact detail to participate in the lucky draw. Please note the contact information is capture on a separate database unrelated to the survey itself and in so doing does not compromise the anonymity of the survey.

In addition to the lucky draw for every survey completed R10 will be donated to the COSAT school.

Should you have any questions regarding the research please feel free to contact the researcher, Danielle Lemmon, on Danielle\_lemmon@yahoo.com.

Name: \_\_\_\_\_

Surname:

Age: \_\_\_\_\_

What year did you complete Grade 12 at COSAT? \_\_\_\_\_

What grade did you start at COSAT? \_\_\_\_\_

Q1 Have you enrolled in an institute of higher learning since leaving COSAT?

Yes (1)

No (2)

If Yes Is Selected, Then Skip To Are your currently studying towards a...If No Is Selected, Then Skip To We would like to find out more about ...

Q2 We would like to find out more about why you did not attend a tertiary institution.

Please select the statements below that explain why you did not attend.

I did not wish to pursue further education. (1)

I was not accepted to a tertiary institution for further study. (2)

I did not have the funding available to pursue tertiary education. (3)

Other (4) \_\_\_\_\_

If I did not wish to pursue fu... Is Selected, Then Skip To Are you currently employed?

If I was not accepted to a ter... Is Selected, Then Skip To Are you currently employed?

If I did not have the funding ... Is Selected, Then Skip To Are you currently employed?

If Other Is Selected, Then Skip To Are you currently employed? If Other Is Not Empty, Then Skip To Are you currently employed?

Q3 Are you currently studying towards a degree?

Yes, I am currently enrolled at a tertiary institution. (1)

No, I have already graduated from a tertiary institution. (2)

If No, I have already graduate... Is Selected, Then Skip to Please tell us about the degrees you ...

Q Which degree programme are you are currently enrolled in?

- Bachelor of Science in Engineering - BSc (Eng.) (1)
- Bachelor of Medicine/Bachelor of Surgery - MBChB (2)
- Bachelor of Science in Medicine - BSc (medicine) (3)
- Bachelor of Social Science (BSocSci) in Mathematics and Applied Mathematics (4)
- Other (5) \_\_\_\_\_

If Bachelor of Science in Engi... Is Selected, Then Skip To At the time of completing this questi...  
If Bachelor of Medicine/Bachel... Is Selected, Then Skip To At the time of completing this questi...  
If Bachelor of Science in Medi... Is Selected, Then Skip To At the time of completing this questi...  
If Bachelor of Social Science ... Is Selected, Then Skip To At the time of completing this questi...  
If Other Is Selected, Then Skip To At the time of completing this questi...  
If Other Is Not Empty, Then Skip To At the time of completing this questi...

Q4 Please tell us about the degree you have successfully obtained.

- Bachelor of Science in Engineering - BSc (Eng) (1)
- Bachelor of Medicine/Bachelor of Surgery - MBChB (2)
- Bachelor of Science in Medicine - BSc (medicine) (3)
- Bachelor of Social Science (BSocSci) in Mathematics and Applied Mathematics (4)
- Other (5) \_\_\_\_\_

Q5 At the time of completing this questionnaire what is your highest level of qualification?

- Higher Certificate and Advanced National Certificate (1)
- National Diploma and Advanced Certificates (2)
- Bachelors degree, Advanced Diploma or B-Tech (3)
- Honours Degree, Postgraduate Diploma or Professional Qualification (4)
- Masters Degree (5)
- Doctors Degree (6)

Q6 If you have obtained a postgraduate degree or diploma, please provide more information below

---

Q7 Which of the following influenced your decision to pursue your chosen field?

- Interest in the specific field (1)
- Ambition to contribute to society (7)
- The profession provides prestige (2)
- The profession provides wealth (3)
- Family pressure to pursue a specific degree (4)
- Family encouragement to pursue a specific degree (5)
- Received funding to pursue a specific degree (8)
- Not accepted for the first degree choice. Please provide name of first degree choice below. (6) \_\_\_\_\_

Q8 Are you currently employed?

- Yes, I am currently employed full time. (1)
- Yes, I am currently employed part time. (2)
- No, I am currently a full time student (4)
- No, I am currently occupied with other activities. (3)

If No, I am currently occupied... Is Selected, Then Skip To If you would like to be considered fo...If No, I am currently a full t... Is Selected, Then Skip To If you would like to be considered fo...

Q9 Please select the industry that best describes your current employer.

- Computer Information Systems/Computer Technology (1)
- Manufacturing (2)
- Medicine (3)
- Science or Physics (4)
- Telecommunications (5)
- Urban planning, Civil Engineering or Construction (6)
- Veterinary or Health Services (7)
- Applied Mathematics or Statistics (8)
- Biotechnology or Pharmaceutical (9)
- Computer Science or Technology (10)
- Dietetics or Sports Science (11)
- Education: Tertiary Education (12)
- Education: Primary or High School Education (13)
- Engineering (mechanical, chemical, etc.) (14)
- Environmental Science (15)
- Food Industry (16)
- Other (17) \_\_\_\_\_

Q10 Is your current position related to your field of study?

- Yes, same field as degree or specialisation (1)
- Yes, similar field as degree or specialisation (2)
- No, different field to degree or specialisation. (3)

If Yes, same field as degree o... Is Selected, Then Skip To If you would like to be considered fo...  
 If Yes, similar field as degre... Is Selected, Then Skip To If you would like to be considered fo...  
 If No, different field to degr... Is Selected, Then Skip To If you would like to be considered fo...

Q11 Are you currently employed?

- Yes, I am currently employed full time (1)
- Yes, I am currently employed part time (2)
- No, I am currently occupied with other activities (3)

Q12 Please select the industry that best describes your current employer.

- Computer Information Systems/Computer Technology (1)
- Manufacturing (2)
- Medicine (3)
- Science or Physics (4)
- Telecommunications (5)
- Urban planning, Civil Engineering or Construction (6)
- Veterinary or Health Services (7)
- Applied Mathematics or Statistics (8)
- Biotechnology or Pharmaceutical (9)
- Computer Science or Technology (10)
- Dietetics or Sports Science (11)
- Education: Tertiary Education (12)
- Education: Primary or High School Education (13)
- Engineering (mechanical, chemical, etc.) (14)
- Environmental Science (15)
- Food Industry (16)
- Other (17) \_\_\_\_\_

Q13 If you would like to be considered for the lucky draw please provide your contact details below.

Name:

Cellphone Number:

Email address